H. O. IRELAND

LEWISTOWN, ILLINOIS, HIGH SCHOOL FOUNDATION DESIGN

CONTENTS

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LEWISTOWN, ILLINOIS,

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(Instructor's Note)

On February 26, 1959, Professor H. O. Ireland of the University of Illinois Civil Engineering Department was contacted over the telephone by an architect designing a new high school at Lewistown, Illinois. Professor Ireland was asked to perform subsoil investigations for determining allowable bearing pressures and foundation requirements.

With this beginning, Professor Ireland entered into the consulting situation upon which this case study is based. He has used such experiences from his consulting practice to provide students in his foundation engineering classes with some exposure to how they might deal with specific problems in a professional situation. Drawing upon his personal files, he has attempted to recreate for his students some of the experiences of a consulting engineer. With himself assuming the role of the client, Professor Ireland placed the student in the role of the consulting engineer.

Professor Ireland, when using this case study, has presented most of the material to the class verbally, thereby retaining some of the identity of the situation as it transpired in his original experience. With this technique he has attempted to force the student to seek additional information relative to the problem. He usually offered no information until the student asked for it even if this required leading the student to the point where the proper question naturally followed. He emphasized the fact that, as he used the case, each student was responsible for seeking and studying further information needed to clarify points of uncertainty.

In explaining his use of the case, he stated that, when encouraging student questions, he often found the students asking questions which were not answered in the case. This he encouraged since he was in no way trying to convince the student that the approach taken in the case was the only one or necessarily the best. Since each student's questions may, at any point, lead discussion far from the succeeding content of the case, Professor Ireland always returned to the case and explained the next step, although not necessarily the best, was the one taken and hence became a fact which the student had to consider as the case continued to develop. This was necessary if the case was to be developed for the student as it developed for Professor Ireland.

This case study is constructed with the intention of allowing the user the possibility of presenting the case to a class in much the same manner as that used by Professor Ireland. That is, the user may verbally explain from the Complete Case History the situation as it developed in the case. With this method, the student would be put in the role of the consultant,

and the user would have the information available as the student requested it. To accelerate the transfer of data, exhibits are provided to be handed to the students where large packets of information are involved.

Included with the instructor's Complete Case History (II) are suggested questions which might be asked by the instructor to direct the discussion along the lines which the actual case followed.

Rather than create for the student the role of a consulting engineer, the instructor could hand out the entire case to a class and ask that they prepare to discuss the case at the next class meeting. With this usage, the class could be asked to discuss the validity of the decisions presented and the possibility of other ways they might have developed.

A class could also be given the entire case and asked to answer the suggested questions. It is impossible to predict exactly how usage of the case might proceed. It is unlikely that any two classes will respond identically to the case.

One way the case discussion began when Professor Ireland used it for a graduate course in foundation engineering at the University of Illinois was as follows (from a taped recording of the class session):

Professor Ireland: The next project that I would like to discuss with you is a high school located at Lewistown, Illinois. On this project our client is an architect for whom we have worked before, and our first knowledge of the project came when he called us and told us that he had a school in Lewistown and he wanted us to do whatever was necessary by way of foundation investigations to give him information on allowable bearing pressures and foundation requirements. (10 second pause) What is your first step?

Student: I would like to know a little about the geology of this area.

Professor Ireland: Well, he has just called us up, and we haven't had any opportunity to check on this, except we know in general that Lewistown is located somewhere almost due West of Champaign, Illinois, and is on the west side of the Illinois River.

Student: How many stories will the building be?

Professor Ireland: We find this to be a one story school. It will have a shop building, an auditorium, and a gymnasium. (Pause) We have worked with this architect before and our usual method of dealing with him is that he tells us he has a project. He may not know yet whether it is to be multi-story or not. He has

done some preliminary thinking on it, and he wants us to get going on the foundation investigation.

Student: Does he have any idea right now of what the general plan of the building will be or what the layout, size, or dimensions will be?

Professor Ireland: Yes, of course, he will provide us with this, but in the meantime, we must proceed with the arrangements for any boring that is going to be made. He has dropped the problem in our lap.

Student: First, I would make a point of, either with him or on my own, going out and taking a look at the site to get some idea of what we are starting with before we even think about setting up any boring program. Also, I would like to see a plan of the site.

Professor Ireland: All right, but first we've got to ask him for the building plan on the site before we can locate the borings, don't we? But what are we going to do about arranging for the boring program?

Student: We can arrange for it right now, say starting with such and such a date, assuming we will have time to take care of all this other stuff.

Professor Ireland: All right. What would be your steps in arranging for a boring program?

Student: Has he given us complete freedom of whom we can hire for this?

Professor Ireland: Yes.

Student: Then I suggest we call a reputable firm that we know of, and have worked with perhaps, and see if they would be free on such and such a date to handle this.

Professor Ireland: Is there any other thing we might want to discuss with the boring firm? . . . . . .

This sample of how one use of the case began can perhaps give rise to other ideas about possible uses. The case discussion may certainly go other directions, and there may be other ways of using the case besides those suggested. Hopefully, there is enough material provided to allow variations to meet the needs of the user.

LEWISTOWN, ILLINOIS, HIGH SCHOOL FOUNDATION DESIGN

On February 26, 1959, Professor Ireland of the University of Illinois Civil Engineering Department was contacted over the telephone by an architect designing a new high school at Lewistown, Illinois. Professor Ireland had previously done consulting work on foundation design for the architect. During the first phone conversation, Professor Ireland was told that the high school was to be one-story with an auditorium and gymnasium in the main building. A shop building was to be separate.

Professor Ireland was asked to perform subsoil investigations for determining allowable bearing pressures and foundation requirements. Since the architect had only recently begun work on the building, no plan drawing of the proposed structure was available. The architect told Professor Ireland that a plan drawing would be available in the near future, however.

SUGGESTED QUESTIONS

A) As a consulting foundation engineer, what more should the consultant know about the project before accepting the job?

If the consultant accepts the job of determining allowable bearing pressures and foundation requirements, what should his next step be after his phone conversation with the architect?

In this first conversation, Professor Ireland agreed to perform the necessary subsoil investigations. He next called a drilling firm, the Raymond Concrete Pile Company and asked them to submit a proposal for borings at the site. Mr. George Higgins of the Raymond Company told Professor Ireland that they could have drilling equipment on the boring sight one or two days

gymnasium (where similarly high loads may be expected from large spans), one near each corner of the classroom-administration wing on the north end (representing the extremities of the building in this direction), one near the proposed boiler room (where a heavier than normal load might be involved as well as excavation below ground surface), and one at the southeast corner of the shop building furthest removed from all other borings. I do not believe that a fewer number of borings should be indicated, but a few more might be justified." Professor Ireland instructed the boring company to take the first boring to 35' depth or four feet into 65 blow[1] material; split spoon samples were to be taken at 2-1/2' intervals to 15' and at five feet intervals thereafter. All bored holes were to be bailed so that water level observations could be made. The boring foreman was to call Professor Ireland with the results before moving off the boring site.

Several days later, the boring foreman phoned Professor Ireland and gave him the boring results shown in Exhibit 6.

) What should the consultant do with the information given him, and what should his next instructions to the boring foreman be?

After reviewing the information given him concerning the first hole, Professor Ireland told the boring foreman to take continuous Shelby tube samples between 13' and 17' in holes numbered five and six. Shelby tube samples usually cost $7.50 per sample.

The drilling crew continued the drillings and collection of samples, providing Professor Ireland with the information seen in Exhibit 7. All borings except number 1 already mentioned and numbers 2 and 3 were terminated in stiff material at 30'. Numbers 2 and 3 terminated in stiff material at 25'. Water levels, after 24 hours, were reported at 4' - 5' in several holes.

) What should the consultant do with the samples obtained?

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[1]65 blow (N value of the soil) - this refers to the number of blows necessary to drive a standard split spoon sampler 12" into the soil being tested, (commonly called Standard Penetration Test, where N = number of blows delivered by a 140 pound ram falling through 30").

With the samples forwarded to him by the drilling company, Professor Ireland had the following tests performed in a soil lab.

On split spoon samples:

1) $*\frac{q_u}{2}$ where possible, otherwise estimate.

2) $**w$ on every bottle sample.

3) classification of all samples.

On Shelby tube samples:

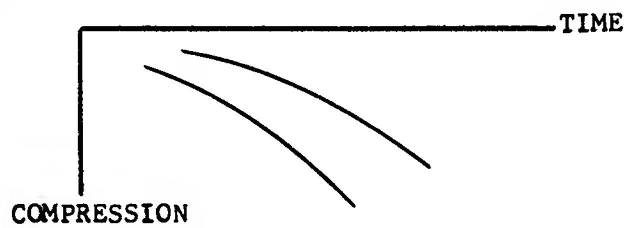
1) consolidation tests on one sample

2) q_u

3) w

From this data, Exhibit 7 was constructed.

Consolidation tests were made on a 2" dia. x 3/8" thick sample of dark brown peat from the 15' depth of boring number five. For this sample, w was 67%; at 14-1/2' in the same hole, w was 30.5% at the top of the sample and 105% at the bottom of the sample. The general appearance of the time consolidation curves was:



These differ from the curves usually obtained from clay in that there is no point of contraflexure.

F) What should the consultant do with the results of the lab tests on the samples?

Are there other tests that should have been performed?

Of the tests performed, were all of them necessary?

In order to plot e - log p curve, the necessary information was taken from the time consolidation curves at a time of 1000 minutes. The resulting curve

$*q_u$ = unconfined compressive strength.

$**w$ = water content.

is shown in Exhibit 8. This e - log p curve indicates the peat is preloaded if the peat is assumed to behave like clay in this respect.

At this point, more information on the geology of the area was obtained. The peat was recognized as Sangamon Soil.[1] The soil below the peat was seen to be Illinoian till; the soil above the peat was recognized as loess put down during and following the Wisconsin glaciation which did not reach Lewistown. The ground surface was covered with from 1 to 3 feet of topsoil.

By this time the architect was far enough along with the building design to provide Professor Ireland with anticipated foundation loads. The data of Exhibit 9 were supplied. The architect told Professor Ireland that the shop was to be mainly used for wood working. There were to be some small machine tools, such as table saws, wood lathes, and many hand tools, but no equipment such as might be found in a heavy industrial shop.

From having worked with this architect before, Professor Ireland knew that he normally did not use basements in buildings of this type. Instead, he generally provided a utility trench just inside the periphery of the outer wall. Such a trench, usually about five feet deep by four feet wide, was to provide access to water pipes, steam pipes, etc., needed to serve the building.

G) Is more information needed than obtained from analysis of soil samples? If so, how could it be obtained?

(Possible source = Geodex index system for geotechnical literature)

Returning to his investigation of the soil samples obtained, Professor Ireland realized he needed more information on the characteristics of peat. In his literature search, he found one source which presented a method of predicting the time settlement of peat.[2] The source dealt with very wet, spongy peat, however ($\underline{w}$ between 700% and 1000%). Hanrahan found that he was able to predict the settlement of a thick specimen by relating it to the action of thin specimen. He found that the magnitude of settlement of

[1] The Sangamon is an interglacial stage that occurred between the Illinoian and Wisconsin glacial periods.

[2] E. T. Hanrahan, "An Investigation of Some Physical Properties of Peat," Geotechnique, September, 1954.

the thick specimen is directly proportional to the ratio of the heights of the specimens under comparison. The settlement time is proportional to the square of the ratio of the heights. i.e.:

$$S \text{ field} = \frac{H \text{ field}}{H \text{ lab}} \times S \text{ lab}$$

$$\text{and } T \text{ field} = \left(\frac{H \text{ field}}{H \text{ lab}}\right)^2 T \text{ lab}$$

H) What correlation can be made between the characteristics of the peat samples obtained and the peat discussed in Hanrahan?

It can be seen that the peat under study by Professor Ireland has a much lower water content than that reported on by Hanrahan. Professor Ireland concluded that if water content is a measure of compressibility, excessive settlements should not be expected since the peat samples were relatively dry. Using Hanrahan's procedure, time settlement curves were plotted of:

$P = 350$ lb/ft^2 and $P = 700$ lb/ft^2.

for a four and one-half foot thick layer, the thickest layer detected. These two pressure were the first two load increments used in the consolidation test. Professor Ireland concluded that for a foundation bearing pressure of 2000 lb/ft^2, the stress in the peat would be about 240 lbs/ft^2, which is somewhat less than the pressures plotted. The plots are shown in Exhibit 10.

I) What conclusions can the consultant draw from these curves?

From these curves, Professor Ireland observed that at $P = 240$ lb/ft^2 (not plotted), the settlement should be less than 1". The loess above the peat is not typical, however; instead, it is weathered with higher compressive strength than is customary.

J) What recommendations should the consultant make?

After analysis of all information gathered, Professor Ireland made his recommendations to the architect (Exhibit 11). He concluded that the strength of the subsoil was generally much greater than 2000 lb/ft^2, but recognized that in some places a strength of 2000 lb/ft^2 was likely. He felt the

settlements calcu ated for peat were subject to many uncertaint . He recognized also that th re would be settl ts due to consolidation of si above and bel the peat, but he did not believ an accurate f r ast of the settlement could be made. He did expect that it would be serious, however.

Profess r I eland recommended the use of spread footings. He predicted some settlement resulting in wall acks which would open up with time. He sugges ed that, to avoid settlement, 25-30 foot treat ti ber piles could be used, but he added that this would greatly increase the cost.

He recomme ded that the footings be located such that DL + LL ·2,000 lb/ft^2. He cautioned, however, against over stimating the magnitude of the live load. He said that, to minimize settlement, fill should be avo ded wherever possible, with two feet of compacted fill considered a maximum. He further stated that any fill should be compacted at water content equal to the plastic limit. He recommended that vertical construction joints be used at each change in structure configuration to localize cracking. He felt that most settlements would occur during the first year, and therefore suggested that interior decorating be delayed one year so that expected cracks can be covered.

He also stated that a time settlement history would be useful to check the action of the peat. A suitable series of reference marks on the footings could provide such a history. If careful records of settlements were kept during construction, he felt the necessity for delaying interior decorating could be more accurately determined.

Conversations in 1964 with the architect and school superintendent indicated that the building is performing satisfactorily with no visible signs of settlements.

K) Do you agree with the recommendations made by Professor Ireland?

PHYSIOGRAPHIC DIVISIONS OF ILLINOIS

M. M. LEIGHTON, GEORGE E. EKBLAW, AND LELAND HORBERG

ABSTRACT

The classification proposes minor modifications in Fenneman's divisions and recognizes subdivisions of the Till Plains and Great Lakes sections, based largely on glacial features. The boundaries and characteristic features of the subdivisions are described, and their origin and relations to glacial features and bedrock topography are discussed.

INTRODUCTION

During the last sixty years increasing attention has been given to physiographic classification; and the broad outlines first conceived by W. M. Davis, J. W. Powell, and others have crystallized into a widely accepted classification for the United States. The establishment of this classification was due largely to comprehensive studies by the late N. M. Fenneman (1914, pp. 84–134; 1928, pp. 261–353; 1931; 1938). In these studies it was recognized that, with the progress of topographic and geologic mapping and the advances in geomorphic knowledge, numerous refinements and revisions would be made. It is the purpose of the present report to make such adjustments of Fenneman's regional boundaries in Illinois as are warranted by present information and to delineate smaller subdivisions which distinguish physiographic differences that can be shown on large-scale maps and which can be used in regional studies within the state (table 1 and fig. 1). These subdivisions, in turn, may be broken down later into still smaller units which may be used as a basis for description in quadrangle reports and other local studies. Local physiographic areas of this type have been described by F. M. Fryxell (1927, pp. 1–53) and by H. B. Willman (1942, pp. 31–37). In the present paper only the distinctive characteristics of the larger subdivisions are summarized.

The report is the outgrowth of geomorphic and glacial investigations carried on by Leighton since 1919, by Ekblaw since 1923, and of recent studies of the bedrock topography and subsurface Pleistocene deposits by Horberg. Copies of a preliminary draft of the map of physiographic divisions of Illinois were prepared in 1944 and furnished to the Committee on Drainage Basins and Flood Control of the Illinois Post-war Planning Commission and to the Illinois Legislative Flood Investigating Commission.

GENERAL DESCRIPTION AND REGIONAL RELATIONS

Illinois is essentially a prairie plain, and, compared with many other states, it presents few striking physiographic contrasts. The relief over most of the state is moderate to slight and is not sufficient to exert a marked effect on climate. Situated in the south-central part of the great Central Lowland (fig. 2) and near the confluence of major lines of drainage, it is the lowest of the north-central states. The mean elevation is about 600 feet above sea-level, compared with 700 feet for Indiana, 1,050 feet for Wisconsin, 1,100 feet for Iowa, and 800 feet for Missouri (Gannett, 1892, p. 289). The total relief of the state is 973 feet, the highest point, 1,241 feet above sea-level, being Charles Mound in the northwest corner of the state, and the lowest point, 268 feet above sea-level, the junction of the Ohio and Mississippi rivers. The greatest local relief is near the major valleys, especially within the driftless uplands of northwestern and southern Illinois, and reaches a maximum of 775 feet between Williams Hill, 1,065 feet above sea-level, and the Ohio River Valley, 290 feet above sea-level, in Pope County of southern Illinois. The local relief in most counties in the state, however, is less than 200 feet.

Although large-scale relief features are absent, the physiographic divisions of the state are readily apparent and assume great local significance. More than nine-tenths of the state lies within the Central Lowland, all of which is glaciated except the Wisconsin Driftless section in northwestern Illinois. The other provinces—Ozark Plateaus, Interior Low Plateaus, and Coastal Plain [illegible] entirely outside the glacial boun[illegible] southern and southwestern Illinoi[illegible].

TABLE 1

PHYSIOGRAPHIC CLASSIFICATIONS OF ILLINOIS

Classification by Fenneman	Classification by Leighton, Ekblaw and Horberg
Central Lowland province	Central Lowland province
Great Lake section	Great Lake section Chicago Lake Plain Wheaton Morainal Country
Till Plains section	Till Plains section Kankakee Plain Bloomington Ridged Plain Rock River Hill Country Green River Lowland Galesburg Plain Springfield Plain Mount Vernon Hill Country Dissected Till Plains section
Wisconsin Driftless section	Wisconsin Driftless section
Ozark Plateaus province	Ozark Plateaus province Lincoln Hills section
Salem Plateau section	Salem Plateau section
Interior Low Plateaus province Shawnee section	Interior Low Plateaus province Shawnee Hills section
Coastal Plain province	Coastal Plain province

FACTORS DETERMINING PHYSIOGRAPHIC CONTRASTS

The physiographic contrasts between various parts of Illinois are due to the following factors and conditions: topography of the bedrock surface; extent of the several glaciations; differences in glacial morphology; differences in age of the uppermost drift; height of the glacial plain above main lines of drainage; glaciofluvial aggradation of basin areas; and glaciolacustrine action.

TOPOGRAPHY OF THE BEDROCK SURFACE

Recently acquired knowledge of the topography of the bedrock surface of Illinois, so widely obscured by the glacial

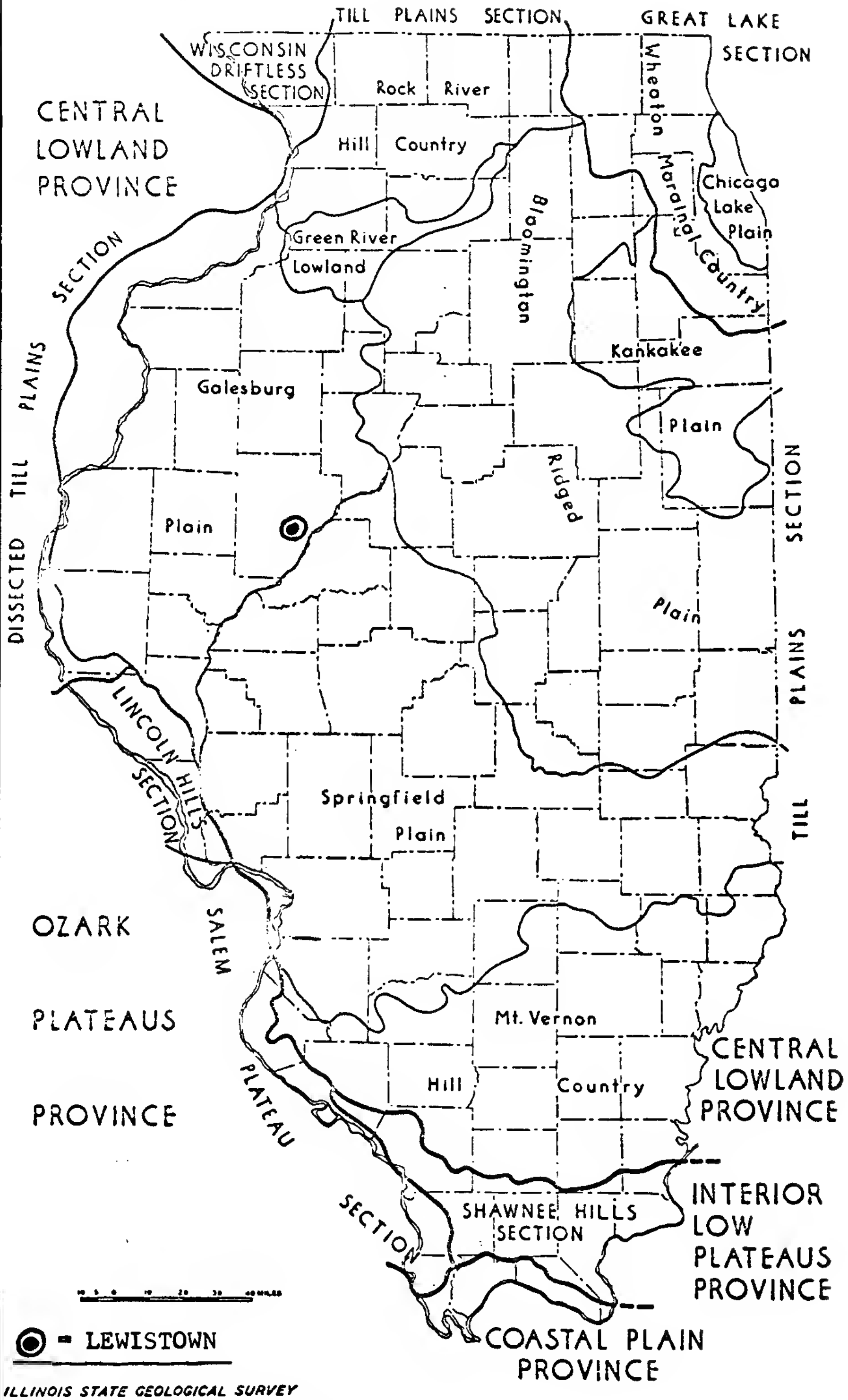


FIG. 1.—Physiographic divisions of Illinois, by Leighton, Ekblaw, and Horberg

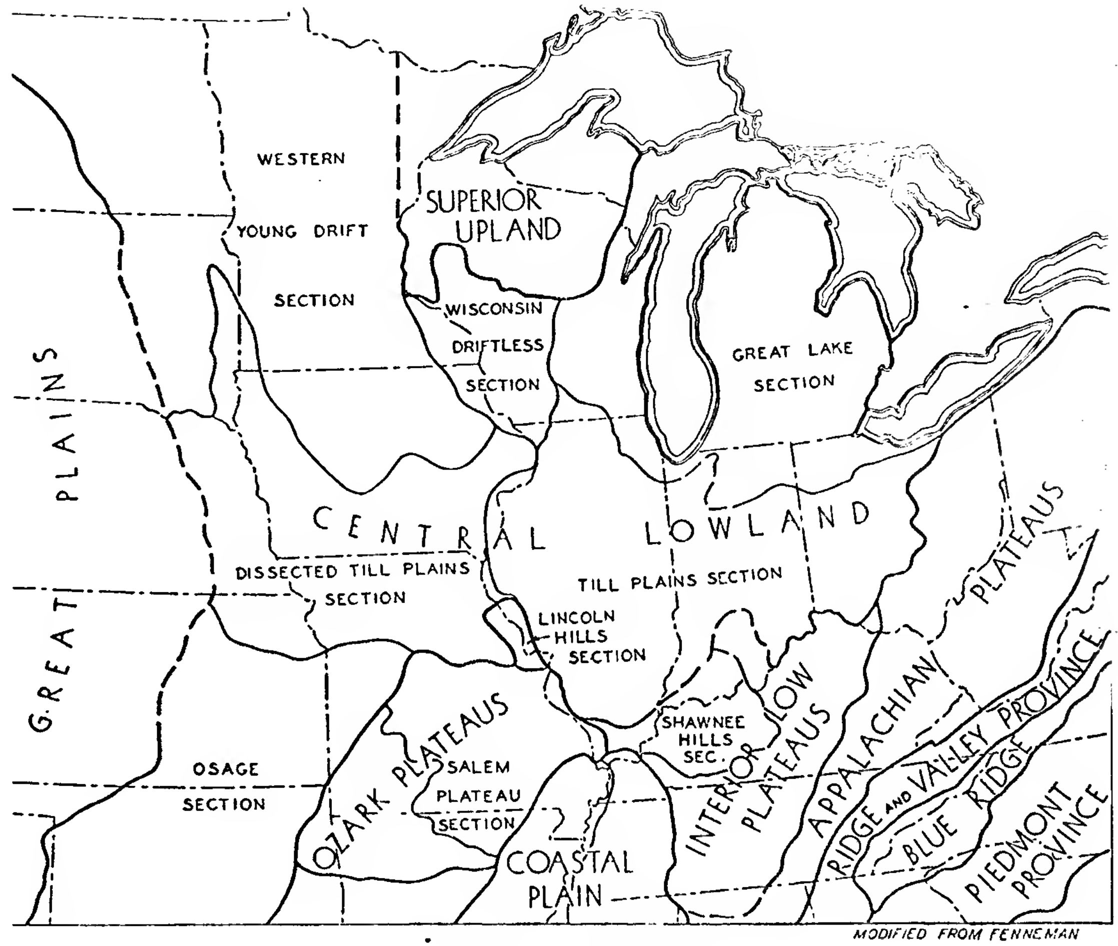


FIG. 2.—Major physiographic divisions in central United States (after Fenneman)

Exhibit 1 (cont.)

II

deposits, emphasize the great importance of this factor in the shaping of the broad physiographic features of the state (Horberg, 1946, pp. 179–192). Prior to glaciation an extensive lowland, eroded on the weak Pennsylvanian rocks of the Illinois basin, covered most of central Illinois. Bordering it on the north, west, and south were uplands that had been developed, for the most part, on the more resistant older Paleozoic limestones and dolomites. This ancient pattern is reflected to an important degree in the present land surface. The extensive lowland of central Illinois provided conditions for the thickest accumulation of glacial deposits and the development of the prairie plains of this portion of the state. The higher uplands of northwestern Illinois and of southern Illinois (the Shawnee Hills) prevented the further movement of the potent Illinoian glacial lobe and caused striking physiographic juxtapositions.

EXTENT OF THE SEVERAL GLACIATIONS

The effect of the extent of several glaciations is most apparent in the physiographic contrasts between the glaciated and nonglaciated areas of the state—the Wisconsin Driftless section and the bordering Rock River Hill Country in the northwest and the Shawnee Hills section and the Mount Vernon Hill Country in the south. This emphasis upon glaciation, however, should be modified by that measure of difference which already existed in the preglacial landscape. Even so, there is no denying the fact that a topographic revolution resulted from glaciation.

The successive superposition of younger drift-sheets upon older in some parts of Illinois and the deposition of only one drift-sheet in other parts also produced physiographic contrasts in the present topography (fig. 3). The bedrock control that characterizes the Mount Vernon Hill Country and most of the Rock River Hill Country is due to the fact that these regions have but one glacial mantle (the Illinoian), whereas the remainder of the glaciated area of the state was buried beneath either two or three drift-sheets. Nebraskan, Kansan, and Illinoian drifts are present in western Illinois, the first two from the Keewatin field; Kansan, Illinoian, Wisconsin, and possibly Nebraskan drifts from the Labradorean field are present in northeastern Illinois; and Kansan and Illinoian drifts (Labradorean) are present in west-central and south-central Illinois.

DIFFERENCES IN GLACIAL MORPHOLOGY

Two contrasting types of topography —the Wheaton Morainal Country and the Bloomington Ridged Plain—impressively illustrate differences in glacial morphology. When the Wheaton Morainal Country was formed, the ice lobe was more confined to the deep Lake Michigan basin, and the moraines are closely huddled together. In molding the Bloomington Ridged Plain, the glacier was more extensive and more widely radiating, and during its receding and readvancing substages it formed moraines widely spaced, alternating with nearly featureless ground-moraine plains. The moraines are also generally smoother than the bold moraines of the Wheaton Morainal Country.

DIFFERENCES IN AGE OF THE UPPERMOST DRIFT

Physiographic contrasts have also been produced by differences in age of the uppermost drift, as in the case of the Bloomington Ridged Plain compared with the Springfield Plain or the Galesburg Plain. The more youthful drift of the Bloomington Ridged Plain is responsible for the preservation of its glacial landscape; the greater age of the other two is responsible for their erosional features.

HEIGHT ABOVE MAIN LINES OF DRAINAGE

The effect of height above main lines of drainage on physiographic contrasts is the basic factor in the differentiation of the Galesburg Plain from the Springfield Plain. The Galesburg Plain is sufficiently higher above the Illinois River so that its valleys are more sharply incised than were those of the Springfield Plain, and they have different stream regimens.

GLACIOFLUVIAL AGGRADATION OF A BASIN AREA

The Green River Lowland is an example of the glaciofluvial aggradation of a basin area.

GLACIOLACUSTRINE ACTION

The Chicago Lake Plain is an example of glaciolacustrine action.

PHYSIOGRAPHIC DIVISIONS

GREAT LAKE SECTION

The Great Lake section of the Central Lowland province is separated from the Till Plains section to the south because of the bold encircling moraines of Lake Michigan basin, the greater prominence of lakes, and the extent of lacustrine plains in this area. In Illinois a purely topographic boundary between the two sections was drawn by Fenneman along "the outer edge of certain late Wisconsin moraines," which, south of the Kankakee River, form "the western rim of the 'Kankakee swamp . . . .' " (1928, p. 315). In this report the boundary is drawn as follows: Along the west border of the Tazewell Marengo ridge (fig. 4) and the Wisconsin-Illinois state line to a point in central Kane County where the Elburn moraine turns westward and southwestward; then southeasterly along an arbitrary topographic boundary to the Cary Valparaiso moraine in western Du Page County, along the outer edge of the Valparaiso moraine southward to the Will County line, and along the outer edge of the closely related Rockdale-Manhattan moraine southward and southeastward to the Indiana-Illinois state line. This boundary coincides, in general, with Fenneman's. The only significant difference is in eastern Kankakee County, where the "Kankakee swamp" is excluded from the section, because the area is an alluviated glacial drainageway and lacks the characteristics of the true lacustrine plains found elsewhere in the section (Ekblaw and Athy, 1925, pp. 417–428). A similar revision of the boundary in the adjoining part of Indiana is implied.

The section is subdivided into the Wheaton Morainal Country and the Chicago Lake Plain, the boundary being marked by the highest (Glenwood) shoreline of glacial Lake Chicago.

Chicago Lake Plain.—The Chicago Lake Plain is the well-known featureless "prairie" of early writers of the area. It is characterized by a flat surface, underlain largely by till, which slopes gently lakeward and is interrupted by low beach ridges, morainic headlands and islands, and by two large glacial drainageways along the Des Plaines River and Sag Channel (Bretz, 1939, pp. [illegible]). The beach ridges include well-developed spits and bars, which parallel the lake shore or funnel southwestward toward the outlet channel along the Des Plaines River. Blue Island, a prominent morainic island, is situated just east of the outlet channel and rises about 50 feet above

Exhibit 1 (cont.)

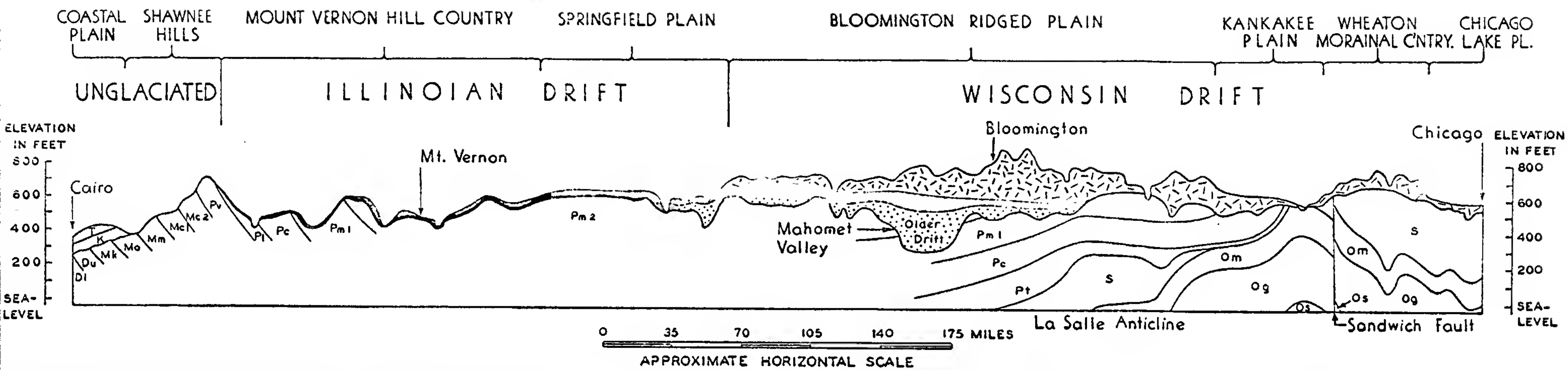


FIG. 3.—Diagrammatic cross section from Cairo north to Bloomington and thence northeast to Chicago, showing (1) physiographic divisions, (2) glacial deposits, (3) profiles of present and bedrock surfaces, and (4) succession and structure of bedrock formations. Note that the ratio of the vertical scale to the horizontal scale, 462:1, exaggerates the dip of the bedrock formations.

KEY TO BEDROCK FORMATIONS

T —Tertiary system
K —Cretaceous system
Pm2—McLeansboro group, upper part
Pm1—McLeansboro group, lower part
Pc —Carbondale group
Pt —Tradewater group
Pv —Caseyville group
Mc2—Chester group, upper part
Mc1—Chester group, lower part
Mm —Meramec group
Mo —Osage group
Mk —Kinderhook group
Du —Devonian system, upper part
Dl —Devonian system, lower part
S —Silurian system
Om —Maquoketa formation
Og —Galena and Platteville formations
Os —St. Peter sandstone

Exhibit 1 (cont.)

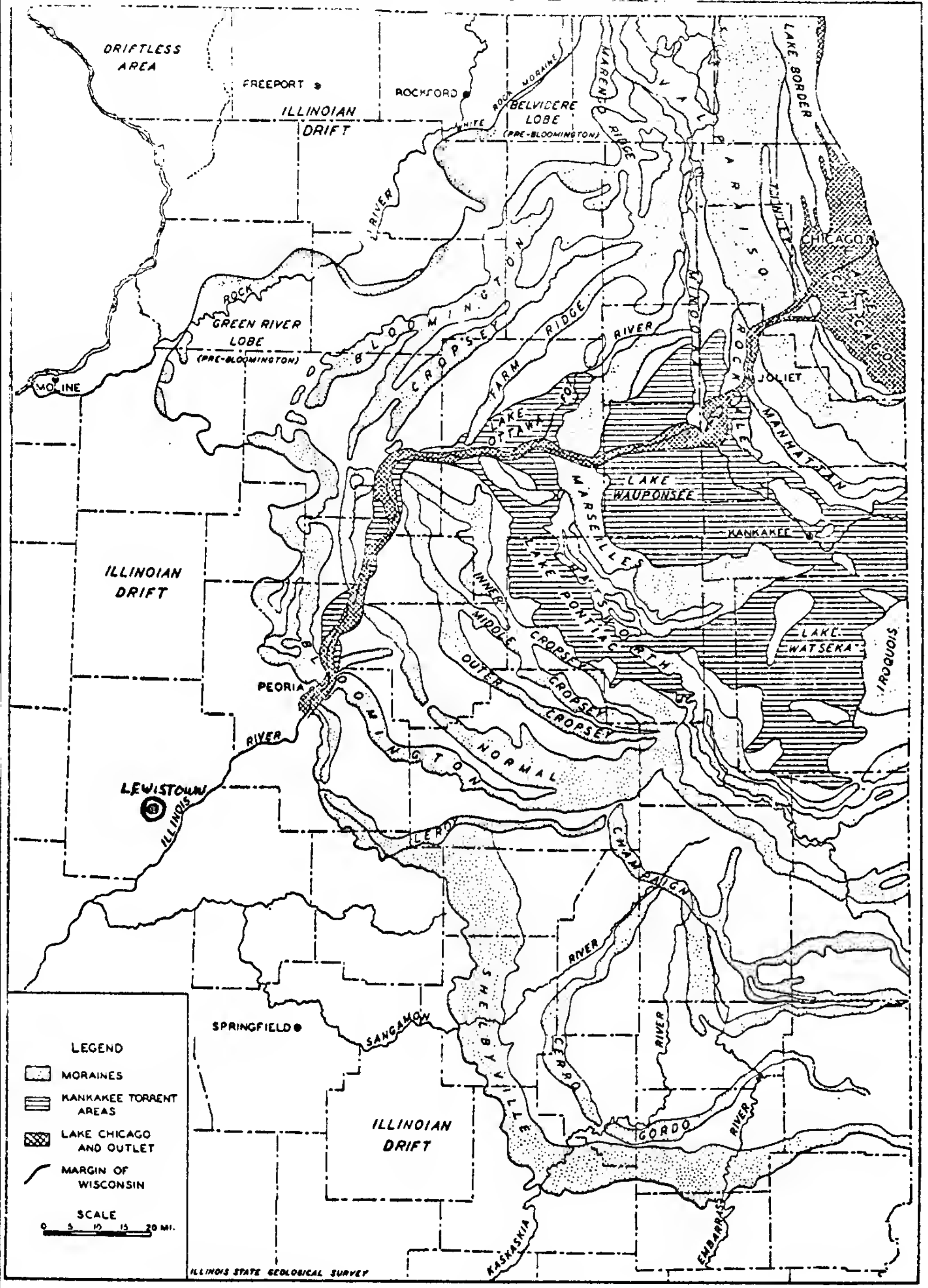


FIG. 4.—Glacial map of northeastern Illinois

the plain. Dunes, which are so conspicuous along the lake shore farther east, are scarcely recognizable and are found in only a few scattered localities.

Originally much of the lake plain was swampy and poorly drained. Its three rivers—the Chicago, the Calumet, and the Des Plaines—are without true valleys and have courses determined largely by beach ridges.

Wheaton Morainal Country.—The Wheaton Morainal Country is characterized by glacial morainic topography (mostly of the Cary substage), which is more complex in detail and has more lakes and swamps than do the open stretches of the adjoining Bloomington Ridged Plain. It includes a series of broad parallel morainic ridges, which encircle Lake Michigan. In detail the topography is complicated by a variety of elongated hills, mounds, basins, sags, and valleys. The area is dominated by the Valparaiso moraine, which has the highest elevation and, except where interrupted by valleys, is continuous from Wisconsin to Indiana. With the exception of the Tinley moraine, all other moraines are discontinuous geographic features—those in front of the Valparaiso moraine are overridden by it and those behind are either interrupted by the Chicago Lake Plain or merge with ground moraines. Kames, kame terraces, kettles, basins, and eskers, although not abundant, occur more commonly than elsewhere in the state. Fox Lake and associated lakes are conspicuous water bodies. Small basins of extinct lakes and ponds underlain by stratified silts and clays are found throughout the area.

The topography is determined essentially by thick Wisconsin drift of the Lake Michigan ice lobe, the deposits of which completely buried the underlying bedrock surface. Older Illinoian drift occurs below the Wisconsin deposits along the outer margin of the section in [illegible] and McHenry counties; [illegible] this older drift appears to have [illegible] moved before the deposition of [illegible] consin drift (fig. 3).

Postglacial erosion has been slight an[illegible] is restricted largely to youthful valle[illegible] along the Fox and Des Plaines rivers. Locally along the Des Plaines Valley near Lemont the Valparaiso drift-sheet is thin, and its major features are determined by a pre-Valparaiso valley system eroded into older underlying drift (Bretz, 1939, p. 52).

Geologic history.—The outer moraines in the Great Lake section, including the Marengo, Hampshire, and Cropsey, were formed during the Tazewell substage of the Wisconsin glaciation, whereas the Valparaiso, Tinley, and Lake Border moraines were deposited during the succeeding Cary substage. The Fox River Valley and the valleys of the east and west forks of Du Page River were trenched, apparently by torrential waters, before the advance of the Cary ice. During glacial recession, large blocks of stagnant ice became buried and, upon melting, left the large basins now occupied by Fox Lake and associated lakes.

As the Cary glacier withdrew into the basin of Lake Michigan, Lake Chicago was impounded behind the Tinley and Lake Border moraines, and its discharge waters eroded the outlet channel along the Des Plaines Valley. With retreat of the ice beyond the Straits of Mackinac, this lower eastward outlet into the Atlantic Ocean drained Lake Chicago, and the Chicago Lake Plain emerged with essentially its present aspect. Unlike the beaches north of Milwaukee, the beaches of the Chicago Lake Plain were not subsequently tilted by differential uplift of the region.

The Till Plains section, which covers about four-fifths of Illinois, is by far the largest physiographic division in the state, and in it seven subdivisions are recognized: the Kankakee Plain, Bloomington Ridged Plain, Rock River Hill Country, Green River Lowland, Galesburg Plain, Springfield Plain, and the Mount Vernon Hill Country. The section is characterized by broad till plains, which are uneroded or in a youthful stage of erosion in contrast with the maturely eroded Dissected Till Plains on the older drift-sheets to the west. The outer boundary coincides closely with the margin of the Illinoian drift.

Kankakee Plain.—The Kankakee Plain is a level to gently undulatory plain, with low morainic islands, glacial terraces, torrent bars, and dunes. It is partially fluviolacustrine in origin, but it differs from the lake plains of the Great Lake section in that the lakes which covered it were temporary expansions of glacial floods and did not extensively alter its surface either by deposition or by erosion, except along the courses of strong currents. It could be considered a modified intermorainic basin, floored largely with ground moraine and bedrock.

The district is enclosed by the Iroquois, Manhattan, and Minooka moraines of Cary age on the east and northeast and by the Marseilles and Chatsworth moraines of Tazewell age on the west and south.

Most of the region is poorly drained by shallow low-gradient streams which follow constructional depressions. The two major streams—the Kankakee and the Des Plaines—occupy glacial sluiceways, which, near Kankakee and Joliet, are entrenched in Silurian dolomites. The drift is thick to thin and in the Kankakee region scarcely conceals the bedrock surface.

Bloomington Ridged Plain.—The Bloomington Ridged Plain includes most of the Wisconsin moraines of Tazewell age and is characterized by low, broad morainic ridges with intervening wide stretches of relatively flat or gently undulatory ground moraine. In many places the major moraines rise with gentle slopes, and, although they are conspicuous from a distance, they become less so near at hand, whereas the minor moraines are prominent locally. It was in this district more than in any other that the grass-covered stretches of rolling prairie and extensive swamps, described by early settlers, were most typically and extensively developed (Poggi, 1934, pp. 1–124). The outer boundary of the district follows the outer border of the Shelbyville moraine from the Indiana line westward and northward to the Green River Lowland, beyond which it follows the outer border of the Bloomington moraine to its intersection with Hampshire Ridge of the Great Lake section.

The moraines form a series of loops roughly concentric with the outer boundary of the district and from south to north include the following moraines: Shelbyville, Cerro Gordo, Champaign, Leroy, Bloomington, Normal, Outer Cropsey, Middle Cropsey, Inner Cropsey, Farm Ridge, Chatsworth, Marseilles, and Iroquois. The outer moraines are more widely spaced than the inner moraines, and a series of re-entrants in the south-central part of the district indicate an interlobate relationship of the Lake Michigan and Lake Erie lobes. A temporary lake, Lake Ancona (Willman and Payne, 1942, pp. 213–215), is known to have existed behind the Inner Cropsey moraine, but it did not modify the ground moraine to any important degree.

The glacial deposits are relatively thick throughout the district and completely conceal the bedrock topography, except locally. Illinoian and older drift are present below the Wisconsin in most places, so that the level aspect of present drift-plains is due largely to the presence of the older drift-sheets, which filled in and covered the irregularities of the bedrock surface (fig. 3).

Drainage development is generally in the initial stage, and most streams follow and are eroding in constructional depressions, many of which cross morainic ridges. Undrained basins are much less numerous than in the Wheaton Morainal Country and occur mainly along the morainic ridges. The valleys of principal streams are larger and more numerous than in the Great Lake section, owing in part to greater areal extent of this division and to somewhat greater age, and they have floodplains bordered by valley-train terraces. The Illinois River, the master-stream of the district, has a broad flat-bottomed valley with steep walls and is bordered by numerous narrow steep-walled valleys with steep gradients. Between the "Big Bend" and Peoria the valley coincides with the large pre-Wisconsin valley of the ancient Mississippi and is wider and has a lower gradient than the upstream part of the valley, which is much younger.

Green River Lowland.—The Green River Lowland is a low, poorly drained plain with prominent sand ridges and dunes. It is bounded on the north and south by the Shelbyville moraine of the Green River lobe and on the east by the abrupt front of the Bloomington moraine (Leighton, 1923, pp. 265–281). Most of the district is modified outwash plain related to the Bloomington moraine, and it is only in the western par[illegible] that it merges with the Cary vall[illegible] of the Rock River. Some of th[illegible] ridges are in part bars on the outwash plain, but many are true longitudinal dunes with a west-northwest orientation or crescentic parabola dunes. North of Geneseo, remnants of the Shelbyville terminal moraine can be recognized. At the close of the Cary substage the lowland was a great swamp in which the two principal rivers, Rock River and Green River, flowed sluggishly along poorly defined valleys choked with outwash.

The present lowland coincides in large part with a broad bedrock lowland which was occupied by the Mississippi River up to the time of Wisconsin glaciation; and a remnant of the old southern valley-wall forms a prominent bluff on the south side of the present lowland.

Rock River Hill Country.—The Rock River Hill Country is characterized by subdued rolling hill-lands in the stage of late youth to early maturity. It includes the eroded Illinoian drift-plain north of the Shelbyville moraine and Meredosia Valley and a fringe of early Wisconsin drift which lies west of Marengo Ridge.

The Illinoian drift is thin throughout most of the district and is not known to be underlain by older till. Thus the major uplands and valleys are determined primarily by the bedrock surface. The Illinoian drift is without marked ridging, and constructional forms are very localized. In the western part of the district, where it borders the Mississippi Valley, thick deposits of loess and fine sand occur as broad ridges, paha, and dunes on the Illinoian till plain.

The major streams flow radially from a central upland into the Mississippi River on the west and the Rock River on the east and south. Their valleys are relatively broad and steep walled and have

terrace remnants of alluvial fill. The Mississippi River a... the upper part of the Rock River occ... y large alluviated valleys. Below the mouth of Kishwaukee River, the Rock has cut a post-Illinoian rock gorge, which extends south to the Green River Lowland. Numerous smaller rock gorges are also present along tributaries which locally are superimposed on spurs of the bedrock upland (Hershey, 1893, pp. 314–325). Most of the minor streams are narrow and V-shaped.

Galesburg Plain.—The Galesburg Plain in western Illinois includes the western segment of the Illinoian drift-sheet. The till plain is level to undulatory with a few morainic ridges and is in a late youthful stage of erosion. It is bounded by Meredosia Valley and the Wisconsin drift border on the northeast, by the Illinois Valley on the southeast, and by the Illinoian drift boundary on the southwest. On the northwest a continuation of the district across the Mississippi River into Iowa is implied. Four morainic ridges can be recognized in the district—two occur near the drift border, a third lies near and roughly parallel to the Illinois Valley, and the fourth—the Buffalo Hart moraine—extends northward through the central part of the region. Locally, the Buffalo Hart moraine is a prominent physiographic feature.

The district is drained by streams which flow from a central upland westward into the Mississippi River and eastward and southward into the Illinois River. The larger valleys are steep walled, alluviated, and terraced, except for local narrowing along postglacial gorges. Much of the district is relatively high above baselevel, so that the minor valleys are numerous, deep, and youthful.

The Illinoian drift is generally thick and is underlain by extensive Kansan and Nebraskan deposits, especially along buried preglacial valleys. Most of the irregularities of the preglacial surface were filled in with older drift, so that, in contrast with the Rock River Hill Country, only gross features of the bedrock topography are reflected in the present landscape.

Springfield Plain.—The Springfield Plain includes the level portion of the Illinoian drift-sheet in central and south-central Illinois. It is distinguished mainly by its flatness and by shallow entrenchment of drainage as compared with the more sharply incised valleys of the Galesburg Plain. The southern boundary of the district, which coincides closely with a similar division made by Paul McClintock in 1929 (fig. 1, p. 28), is drawn along a line south of which the drift thins and bedrock topography becomes a controlling factor; the western boundary follows the edge of the Illinoian drift.

Although the greater part of the district is a flat till plain, the morainic features in the western part of the region are much more conspicuous than elsewhere on the Illinoian drift-sheet. They include the Jacksonville and Buffalo Hart moraines and an extensive area of ridged drift in the Kaskaskia drainage basin. The moraines are low and broad, but they are readily recognized because of their continuity and the associated kames and kame terraces. The Kaskaskia ridges lie just to the east of an interlobate area indicated by the moraines and include an irregular assemblage of gravelly ridges and hills with small intervening plains, some of which are old lake basins. A large proportion of the hills and ridges appear to be kames and crevasse-fillings related to stagnant ice conditions (Ball, 1940, pp. 951–970).

Drainage systems are well developed, and the district as a whole is in a late youthful stage of dissection. The uplands are low with respect to the master-streams, and the valleys are relatively shallow. Most of the principal streams have low gradients and occupy broad alluviated and terraced valleys; the secondary tributaries have wide V-shaped valleys; and the headwaters, flowing essentially on the till plain, have broad shallow valleys and low gradients.

The Illinoian drift is moderately thick and is underlain by older drift except in areas where the bedrock is close to the surface. Only the larger valleys and uplands of the bedrock surface are reflected in the present topography (fig. 3).

Along the southeast side of the Illinois Valley there is a belt of thick loess, with dune-contours characterizing the bluff-margin, but this body of loess thins rapidly to the southeast.

Mount Vernon Hill Country.—The Mount Vernon Hill Country comprises the southern portion of the Illinoian drift-sheet in Illinois and is characterized by mature topography of low relief with restricted upland prairies and broad alluviated valleys along the larger streams. Except for a southern extension of the Jacksonville moraine, glacial land forms are essentially absent. The southern and western boundaries of the district coincide closely with either the outer limits of glaciation or the outer margin of the Carbondale group of the Pennsylvanian system.

A relatively complete drainage system is present, and most streams have broad terraced valleys and low gradients. Natural drainage is good throughout the upland area, but the larger valley bottoms are poorly drained. Extensive aggraded lowlands along the Wabash drainage system to the east and the Big Muddy basin to the west are outstanding physiographic features.

The Illinoian d... ...strict is thin, and deposits of underlying older drift are not known to be pres... t exc... west of Sparta in Rand...ph Cour... present land surface is primarily... rock surface of low relief, which ... slightly modified and ...dued by a mantle of drift (fig. 3).

Geologic history of the Till Plains section.—Prior to glac...tion t... ... Plains section had a long an... complex erosional history (Horberg, 1940, pp. 179–192). An extensive lowland—the central Illinois peneplain—was eroded in the weak Pennsylvanian rocks of the Illinois basin east of the Illinois River; it was bordered on the west and south by uplands, on which remnants of an older erosion surface are extensively preserved. Just prior to glaciation a system of deep bedrock valleys, many of which are occupied by present streams, were entrenched below the level of the central lowland. The gross features of the section as well as local features in the Rock River Hill Country and in the Mount Vernon Hill Country are determined to a large degree by this preglacial topography. The greater relief and higher elevations in the Rock River Hill Country and in the Galesburg Plain are determined by the preglacial uplands, whereas the low plains in the remaining districts reflect the central Illinois peneplain.

With the advent of glacial conditions and the approach of the Nebraskan glacier, there was probably a change from erosion to aggradation along major streams as the result of increased load and drainage derangements. The oldest deposits along the ancient Mississippi Valley (middle and lower Illinois) and its buried eastern fork, Mahomet Valley, appear to represent this stage. This was followed by the Nebraskan glacial invasion, which is known to have covered at

least a large part of the upland of western Illinois. There is no evidence that the early fills in the preglacial valleys were more than partially removed during the succeeding Aftonian interglacial stage. The Kansan glaciers, which followed, advanced from both the northeast (Labradorean center) and northwest (Keewatin center), probably in that order, and together covered most of the district except for the Rock River and Mount Vernon hill lands. Mahomet Valley and its tributaries in the central part of the section were largely buried and, because of the diversion of drainage, were not re-excavated during the ensuing Yarmouth interglacial stage (fig. 3) (Horberg, 1945, pp. 349–359).

With the advance of the Illinoian glacier from the Labradorean center, the ice attained its maximum extent in Illinois, and the entire Till Plains section was ice-covered. Except in the Rock River and Mount Vernon districts, where older drift is largely absent, the ice moved across a subdued land surface with fills of early drift and during retreat left behind a relatively smooth till plain. Following Sangamon erosion, which was not important except locally, the Wisconsin glaciers of the Tazewell stage covered the northeastern part of the state and formed the glacial landscape which is still so extensively preserved.

DISSECTED TILL PLAINS SECTION

The Dissected Till Plains section in western Illinois is represented by a narrow isolated segment of the Kansan drift-sheet maturely dissected into an upland of high relief. The eastern boundary is determined by the Illinoian drift margin and the southern boundary by an arbitrary line, south of which the drift occurs as patches and is unimportant physiographically. From a regional standpoint, essentially the entire section lies west of the Mississippi River, and the eastern boundary of the section was drawn along the river by Fenneman. The refinement of the boundary here proposed is of only local significance.

The Kansan drift in the area is thin, and the topography closely reflects the ruggedness of the underlying bedrock upland. Valley-train terraces along the Missisippi Valley and thick loess deposits on the adjoining bluffs are features of secondary importance. The geomorphic history closely parallels that of the adjoining Ozark Plateaus and is discussed later.

WISCONSIN DRIFTLESS SECTION

The Wisconsin Driftless section, which constitutes the final subdivision of the Central Lowland province in Illinois, is a submaturely dissected, low plateau bordering the outwash-filled valley of the upper Mississippi River. The eastern boundary follows the edge of the Illinoian drift and is unchanged from Fenneman's classification.

The upland is underlain by the Galena-Platteville dolomite and Maquoketa shale of Ordovician age and by outliers of Silurian dolomite. Flat upland areas, which coincide closely with the top of the Galena-Platteville dolomite, are considered remnants of the Lancaster peneplain.[1] A possible higher surface—the Dodgeville peneplain—may be represented by the crests of mounds and narrow ridges capped by Silurian dolomite. Benches clearly controlled by structure occur along the lower reaches of the principal valleys, where the Maquoketa shale has been stripped from the top of the Galena-Platteville dolomite.

The plateau is maturely to submaturely dissected by a number of dendritic drainage systems tributary to the Mississippi. The Mississippi Valley has broad terraced bottom lands and precipitous walls. Most of the minor valleys are youthful, with narrow V-shaped valleys and some with incised meanders. There is considerable underground drainage through small caves and solution channels, but sinkholes and other karst features are not conspicuous. The canyon of Apple River is a prominent local feature resulting from glacial diversion of the former headwaters of Yellow River (Trowbridge and Shaw, 1916, pp. 95–99). As elsewhere, thick loess deposits mantle the bluffs of the Mississippi Valley and thin eastward.

The geomorphic history of the region is largely one of stream erosion and involves numerous uncertainties. The broad outlines, however, may be summarized as follows: (1) development of the Dodgeville surface, probably as a peneplain; (2) rejuvenation and erosional development of the Lancaster surface to a partial peneplain; (3) uplift and entrenchment of the Mississippi bedrock valley and some of its larger tributaries; (4) partial filling of the valley by glacial outwash with a maximum thickness of more than 300 feet; and (5) postglacial erosion.

[1] See Horberg (1946) for bibliography and recent review of the problem.

OZARK PLATEAUS PROVINCE

The Ozark Plateaus province forms a discontinuous upland along the southwest margin of the state and represents the eastern edge of an extensive upland in southern Missouri and northern Arkansas (fig. 2). It includes the driftless and thinly drift-covered cuestas on pre-Pennsylvanian rocks which are structurally and topographically a part of the Ozark dome. Two important modifications of Fenneman's classification are proposed: (1) the Salem Plateau is expanded northward to include the partially drift-covered Mississippian cuesta in Randolph, Monroe, and St. Clair counties, which is clearly a part of the Ozark dome; (2) the Lincoln Hills section, first distinguished by E. M. Shepard (1907, pp. 8, 9–11) in Missouri and later by W. W. Rubey (1936) in Calhoun County, Illinois, is recognized as a new subdivision. Fenneman included both these areas in the Till Plains section of the Central Lowland province.

Lincoln Hills section.—The Lincoln Hills section includes the partially drift-covered dissected plateau above the junction of the Mississippi and Illinois rivers in western Illinois. It is part of a larger upland which, bisected by the Mississippi, lies partly in Missouri. The principal physiographic feature in Illinois is a maturely dissected central ridge, which forms the watershed between the Mississippi and the Illinois rivers throughout the length of the section. As previously noted, the northern boundary is arbitrary, and the eastern boundary follows the Illinoian drift border. The southern boundary with the Salem Plateau is drawn along the Cap au Grès flexure in southern Calhoun County.

The upland is determined by a subsidiary structure of the Ozark dome, the Lincoln fold, along which the more resistant pre-Pennsylvanian limestones and dolomites crop out. In Illinois the plateau is largely underlain by Osage limestones, of which the Burlington limestone is most important physiographically; and the boundaries coincide quite closely with the Mississippian-Pennsylvanian contact. The southern part of the section is driftless except for loess deposits and a single high-channel filling of outwash gravel, presumably Kansan. It has long been known as the Calhoun

Exhibit 1 (cont.)

of Kansan drift are preserved in the northern part of the section.

The plateau surface is rugged and broken by closely spaced valleys and ridges. Restricted areas of flattish to gently rolling upland representing the Calhoun peneplain (Rubey, 1936) are present along the crest of the ridge. The valleys of the Mississippi and Illinois rivers are broad, deeply alluviated, terraced, and have precipitous walls. Most of the minor valleys are narrow, V-shaped, and steeply graded.

Salem Plateau section.—The Salem Plateau comprises the major part of the Ozark dome in southern Missouri, but only two small segments, isolated by the Mississippi River, are present in southwestern Illinois. Both segments are maturely dissected, partially truncated cuestas, dominated by a single central ridge. The northern segment is covered by thin Illinoian drift, but the southern segment lies south of the glacial boundary. In the northern segment an arbitrary boundary with the Shawnee Hills is drawn where the sandstones and conglomerates forming the lower Pennsylvanian escarpment give way to finer sediments and the escarpment dies out, the east margin closely follows the overlapping edge of Pennsylvanian strata, and the northern boundary coincides with the Cap au Grès flexure. The southern segment is delimited from the Shawnee Hills to the east along the contact between Carboniferous and older rocks and follows Fenneman's boundary.

The northern segment is developed on Mississippian strata and lies on the back slope of the Meramec-Osage cuesta, which flanks the Ozark uplift on the north and east. It is underlain by Meramec limestones on the west and north and by Chester strata on the southeast. The plateau is submaturely dissected, and gently rolling summit areas, considered remnants of the Ozark peneplain, occur along the central ridge. Because of the drift mantle, the topography does not appear as rugged as the Lincoln Hills or the Salem Plateau sections. Karst features, developed primarily on the St. Louis limestone, are present at many places within the area. The central ridge forms the watershed for tributary drainage, but the Mississippi and Kaskaskia rivers cross the ridge without regard to structure. The valleys of these two major streams have broad alluvial flats and steep walls, whereas most of the tributaries are youthful.

The south unglaciated segment of the Salem Plateau in Illinois is underlain largely by a thick succession of deeply weathered Devonian chert and cherty limestone formations which on the south are overlapped by Coastal Plain sediments. Structurally, the area is clearly a part of the Ozark dome, but it is complicated by a zone of folds and faults trending north-south and northwest-southeast. A clearly defined physiographic boundary separates the plateau from the Shawnee Hills to the east and north, the contrast being marked by more rugged hills, closer drainage texture, absence of structural control, and higher elevations in the plateau section. Most of the plateau is maturely dissected by intricate dendritic drainage, although small remnants of a flat upland surface representing the Ozark peneplain are preserved throughout the region. The northern part of the segment is drained by streams which head in the Shawnee Hills and flow westward across the plateau into the Mississippi River, whereas in the southern part a central divide separates the Mississippi and Cache Valley drainage. In contrast to other parts of the Ozark Plateau in Illinois, most of the larger tributary valleys, as well as the Mississippi Valley, are deeply alluviated, and only the secondary tributaries are youthful.

Geomorphic history.—The Ozark Plateaus are essentially a preglacial land surface whose erosional history has continued during the glacial period. The oldest landscape features in the province are isolated summit areas, over 800 feet above sea-level, which may be peneplain remnants correlative with the Dodgeville peneplain of the Wisconsin Driftless section and the Buzzard's Point plain (Salisbury, in Weller, Butts, Currier, and Salisbury, 1920, pp. 47–52) of the Shawnee Hills. An alternative interpretation is that they are simply monadnocks on the lower Ozark peneplain. In either case an extensive surface, called the "Calhoun peneplain" in the Lincoln Hills section and the "Ozark peneplain" in the Salem Plateau section, was developed below the level of these isolated remnants and is responsible for the general accordance of summit levels found throughout the plateau at elevations about 700 feet above sea-level. Near the southern margin of the plateau the Ozark peneplain is believed to transect Wilcox (Eocene) strata and therefore to have been completed sometime during the Tertiary (Flint, 1941, pp. 634–636). The weathering and leaching of the Devonian formations in the southern part of the Salem plateau to depths of about 400 feet is of unusual interest and has been ascribed to prolonged alteration under peneplain conditions (Weller, 1944, pp. 101–102). Following completion of the peneplain, and probably prior to erosion of the Central Illinois peneplain, "Lafayette"-type gravels were spread over its surface. It appears likely that the major preglacial drainage lines were determined at this time and that, ... the pene-plain, streams occupying the Mississippi, Illinois, and Kaskaskia valleys became incised without regard to st... There is no clear evidence of the ... ing central Illinois peneplain and ... strath cycles in the region, probably because the weaker formations on which they are elsewhere developed are absent. During the glacial period ... glacial topography was modified by alluviation of the major valleys and by deposition of loess on the uplands.

INTERIOR LOW PLATEAUS PROVINCE

Shawnee Hills section.—The Interior Plateaus in southern Illinois are represented by the western part of the Shawnee Hills section[2] and include a complex dissected upland, underlain by Mississippian and Pennsylvanian strata of varied lithology. It is, in the main, the area generally referred to popularly as the "Illinois Ozarks." The northern margin is drawn along a marked topographic boundary which lies along the inner flank of the lower Pennsylvanian (Caseyville) cuesta just within the Illinoian glacial drift boundary, and the southern boundary follows the northern edge of the overlapping Coastal Plain sediments. These are essentially Fenneman's boundaries, the only important modification being a northwestward extension of the section to include the thinly drift-covered Pennsylvanian cuesta in Jackson and Randolph counties.

The section is situated along the southern rim of the Illinois basin, so that the lower Pennsylvanian cuesta com-

[2] The section was originally distinguished by R. F. Flint (1928, pp. 451–457) and named the "Shawnee Hill Section. Fenneman (1938, p. 435) used the name "Shawnee section." The suggested usage of the term "Shawnee Hills section," in the present report is proposed purely for descriptive reasons.

Exhibit 1 (cont.)

prises the northern p... of the region and a dissected plateau underlain largely by Chester (Mississippian) formation comprises the southern part. This regional tructure is complicated by faulting and ...ding, which to a varying degree in...red a large part of the area.

The Pennsylvanian cuesta forms a ontinuous ridge and watershed, extendng completely across the state. In most places the ridge is maturely dissected by youthful valleys, but remnants of flat upland are locally preserved on narrow ridge crests throughout the length of the escarpment.

The plateau on Mississippian rocks to he south is maturely dissected, and the arger valleys are alluviated. There are numerous minor escarpments, structural benches, fault-line scarps, and subsequent valleys which reflect local structure and the varied lithology of the bedrock. Only small patches of flat upland are present. Karst features in the St. Louis limestone are present near Cave in Rock, Hardin County, and in southentral Union County.

Geomorphic history.—The erosional history of the region is similar to that of he Ozark Plateaus previously outlined. Remnants of the Ozark peneplain appear o be extensive along the Pennsylvanian scarpment, and local higher summits, specially to the east, may represent an older (Buzzard's Point plain) cycle (Salsbury, in Weller, Butts, Currier and Salisbury, 1920, pp. 47–52). Lower suraces on the Mississippian rocks, 500–550 eet and 600–650 feet in elevation, are of ncertain origin. Remnants of "Laayette"-type gravels are found both on he escarpment and at lower elevations outh to the Ohio River. A deep weathred zone on the gravels overlain by loess ndicates that a long period of stable conitions followed their deposition and that the major period of valley-cutting occurred late in the Tertiary (Weller, 1940, p. 45). Loess deposition and valley alluviation were the principal events during the glacial period.

COASTAL PLAIN PROVINCE

The Coastal Plain in Illinois includes the southern tip of the state and is underlain by unconsolidated Cretaceous and Tertiary sediments, which overlap the older Paleozoic rocks to the north. Three physiographic subdivisions are recognized: (1) and (2) the coextensive alluvial plain of the Cache and Mississippi valleys and (3) the Cretaceous hills between the Cache Valley and the Ohio River. The alluvial plains are characterized by terraces and recent floodplain features. The Cretaceous hills are maturely eroded into a low upland of gently sloping knolls and ridges. Outwash and alluvium extend far up tributary valleys, so that the upland is partially buried and certain segments are essentially isolated.

The earliest events in the geomorphic history of the region are indicated by remnants of "Lafayette"-type gravels which occur in the Cretaceous hills. The erosion surface at their base is evidence of a long period of denudation, during which the Coastal Plain deposits were lowered and stripped back. This was followed by deposition of the gravels, their weathering under stable conditions, establishment of major drainage lines, and final dissection of the bedrock topography. Prior to glaciation, Cache Valley was occupied by the Ohio River and the present Ohio Valley was occupied by the Cumberland and Tennessee rivers. During Illinoian or possibly Wisconsin time the valleys were aggraded to the level of the divide between the Ohio and the Cumberland rivers at Bay City in southern Pope County, and the present lower course of the Ohio was opened. Both courses were kept open during subsequent stages, so that flood waters still pass through Cache Valley, and only in relatively recent time th... southern channel became the perm...e.. course of the river.

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WILLIAM, H. B., and PAYNE, J. N. (1942) Geology and mineral resources of the Marseilles, Ottawa, and Streator quadrangles: Illinois Geol. Survey Bull. 66.

Exhibit 1 (cont.)

Exhibit 2 Test Boring Cost Proposal.

RAYMOND

CONCRETE PILE COMPANY

A DIVISION OF RAYMOND INTERNATIONAL INC.

140 CEDAR STREET NEW YORK 6, N.Y.

ATLANTA 3, GA.
57 FORSYTH STREET, N. W.
BALTIMORE 2, MD.
1111 MERCANTILE TRUST BUILDING
BOSTON 16, MASS.
31 ST. JAMES AVENUE
CHICAGO 3, ILL.
111 WEST MONROE STREET
CLEVELAND 15, OHIO
25 PROSPECT AVE. S. W.
DETROIT 2, MICH.
7430 SECOND AVENUE
HOUSTON 6, TEXAS
610 WOODROW STREET
KANSAS CITY 5, MO.
127 WEST TENTH STREET
LOS ANGELES 17, CALIF.
816 WEST FIFTH STREET
MIAMI 34, FLORIDA
2505 PONCE DE LEON BLVD.

METAIRIE, LA
242 FOCIS STREET
OAKLAND 3, CALIF.
156 98TH AVENUE
PHILADELPHIA 7, PA.
1343 ARCH STREET
PITTSBURGH 22, PA.
304 FOURTH AVENUE
PORTLAND 10, ORE.
2323 N. W. FLANDERS STREET
ST. LOUIS 1, MO.
706 CHESTNUT STREET
SALT LAKE CITY 1, UTAH
220 GREYHOUND TERMINAL BUILDING
SAN FRANCISCO 4, CALIF.
235 MONTGOMERY STREET
SEATTLE 8, WASH.
6755 EAST MARGINAL WAY
WASHINGTON 6, D. C.
1625 EYE STREET, N. W.

Our Sixty-Second Year
111 W. Monroe Street
Tel: ANdover 3-3318
Chicago 3, Illinois
February 27, 1959

PW - Lewistown Illinois
Proposed School

Gentlemen:

We hereby propose to furnish all tools, labor, equipment and materials to make the necessary RTB by our usual methods on the site of the Proposed School in Lewistown, Illinois, for the prices and on the terms hereinafter mentioned.

You shall mark the location of each boring on the site and establish the surface elevations referred to a known, fixed datum, supplying us with such data in sketch or plan form; shall furnish sufficient water for the conduct of the work within reasonable hose-pipe distance of the points at which it is to be used (or pay us the cost of pumping or hauling water plus 10% thereon); shall furnish free and uninterrupted entrance to and exit from the site for our equipment, materials and personnel; and shall secure all municipal and other necessary permits. Unless otherwise agreed to herein, we shall not be required to make borings inside or under buildings or structures nor to operate on or over bodies of water, flooded or marshy areas or areas obstructed by brush, piles of rubble, etc.

Each boring shall be carried to the depth required by you unless boulders or materials are encountered which prevent securing further penetration without hard or rotary drilling. "Hard drilling" shall be defined as that requiring 60 or more blows of a 140-pound weight falling 30 inches to drive a 2" o.d. x 1⅜" i.d. sample spoon 12 inches.

We shall submit to you a graphical record showing the location of each boring together with the vertical arrangement, thickness, geological character and relative hardness of the several strata penetrated (and, in case groundwater is encountered the water-bearing strata and the elevation of the hydraulic grade), accompanied by properly labelled cartridge or core samples thereof; all as indicated by and procured from each boring.

We are protected by Workmen's Compensation Insurance (and/or Employers' Liability Insurance), Public Liability Insurance for bodily injuries with limits of $200,000/500,000, and Public Liability Property Damage Insurance with limits of $50,000/100,000 and will furnish certificates thereof upon request. We assume the risk of damage to our own supplies and equipment. If your contract or purchase order places greater responsibilities upon us or requires further insurance coverage, we will take out additional insurance (if procurable) to protect us, at your expense; but we shall not be responsible for property damage from any cause, including fire and explosion, beyond the amounts and coverage of our insurance.

Price for --------------the necessary------------- RAYMOND TEST BORINGS

shall be as follows: For the delivery to and removal from the site of the work $ 150.00 per drilling rig, plus $ 3.00 per lineal foot of hole drilled below the ground surface, for earth drilling requiring no hard drilling, or $5.00 per lineal foot for hard drilling, as defined on the first page of this proposal.

Should soil load tests be required and ordered by you we shall be paid in accordance with the following schedule:

1. Furnish and deliver steel truss, anchors, plates jacks, etc., capable of applying a total load of 12,000 lbs.

   Lump Sum $200.00

2. Perform load tests not to exceed 12,000 PSF not lower than 8' below present ground surface or water table. $455.00 per test plus the cost of removing all seepage water that cannot be controlled with a 2" pump. If you so desire we will invoice this portion of the work at $15.00 per crew hour.

The above prices are based on our operating a normal single shift 5-day week. Should you desire us to operate additional time and so order, we shall do so--in which case you are to reimburse us for the overtime, extra labor cost plus applicable insurance and Social Security taxes thereon.

Payments shall be made within ten (10) days of the date on which progress invoices are rendered and shall be for ninety percent (90%) of the value of the work performed during the preceding month. Final payment shall be made within thirty (30) days after the completion of the work, covered by this proposal. However, should the total value of the work performed be $1,000.00 or less, payment in full shall be made within ten (10) days of the date on which final invoice shall have been rendered.

Work shall be pushed to completion as speedily as is consistent with good workmanship but subject to all delays from strikes, lockouts, differences with workmen, or any other similar or dissimilar causes beyond our control. It is understood that we operate under accepted Union conditions.

This proposal is made on your warranty that our right to Mechanic's Lien has not been and is not waived. It is made, in triplicate, for your immediate acceptance and is subject to the approval hereon of one of our executive officers.

Respectfully submitted,

RAYMOND CONCRETE PILE COMPANY
A DIVISION OF RAYMOND INTERNATIONAL INC.

ACCEPTED: ....

.... By ....

By.. G. J. Higgins, Superintendent

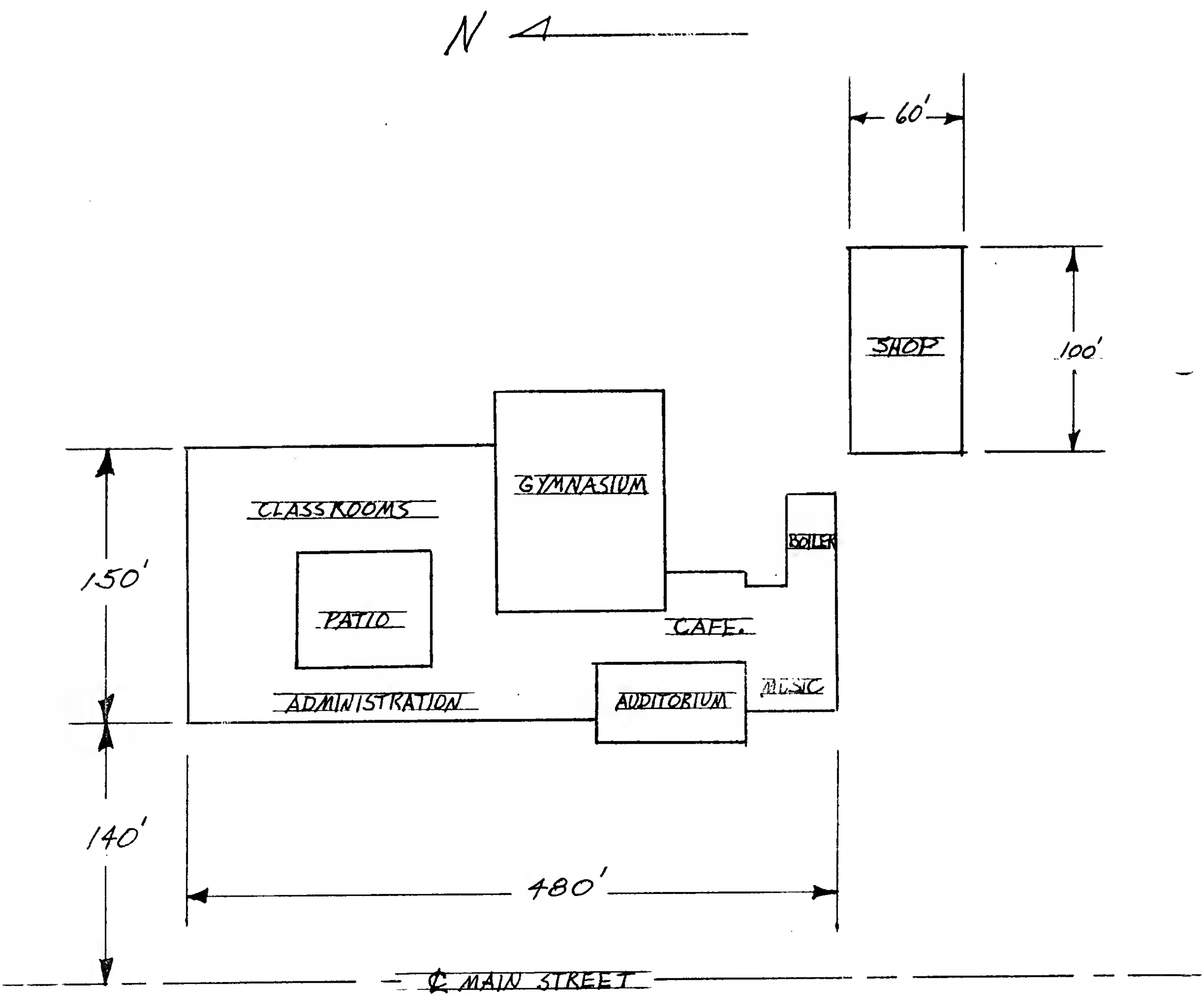
....

APPROVED:

RAYMOND CONCRETE PILE COMPANY
A DIVISION OF RAYMOND INTERNATIONAL INC.

By ....

Exhibit 3: Lewistown, Illinois, High School Plan.



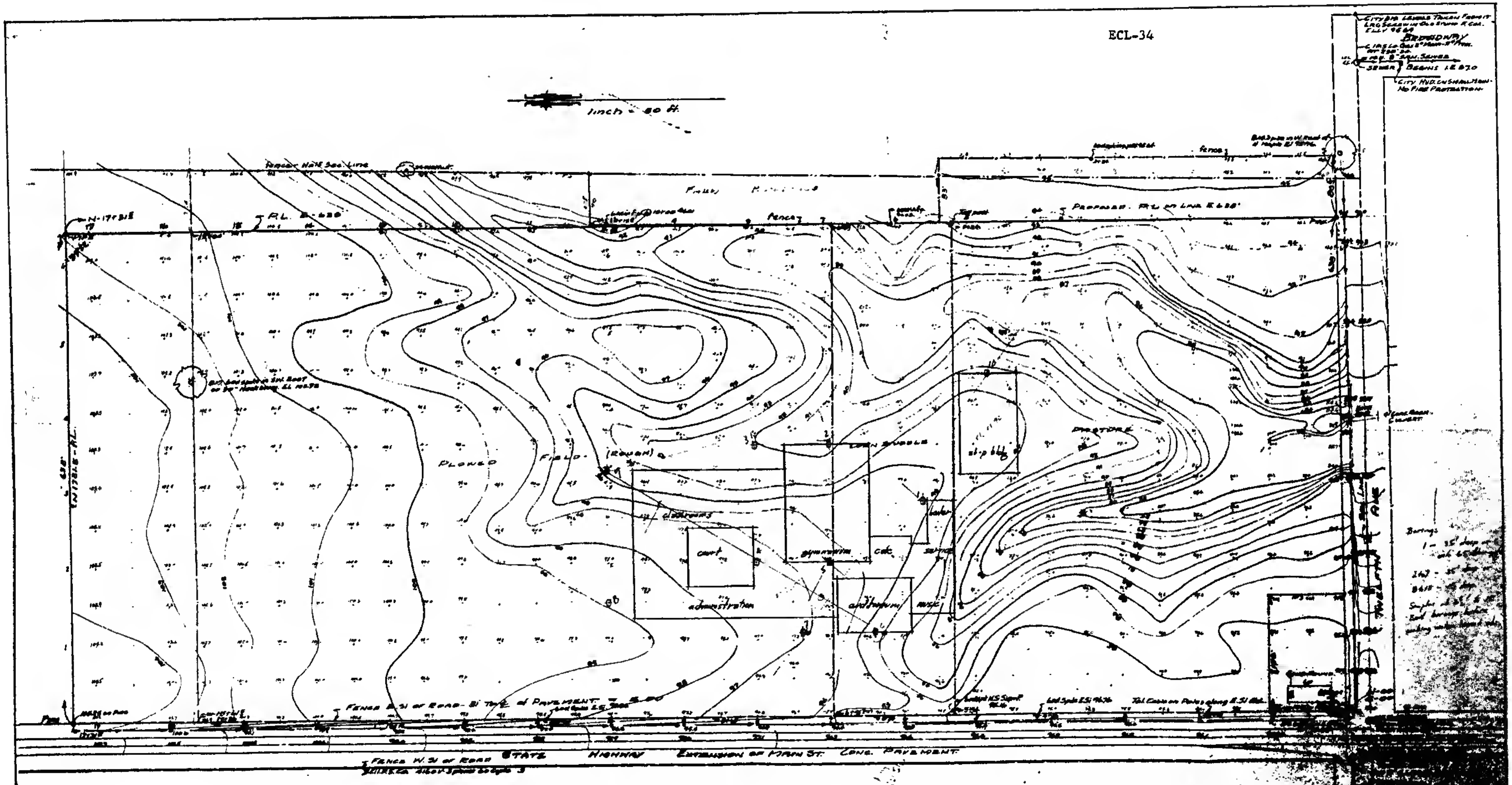


Exhibit 4: Topographical Map of Site, Showing Proposed Building Location.

Exhibit 5: Boring Locations, Lewistown, Illinois, High School

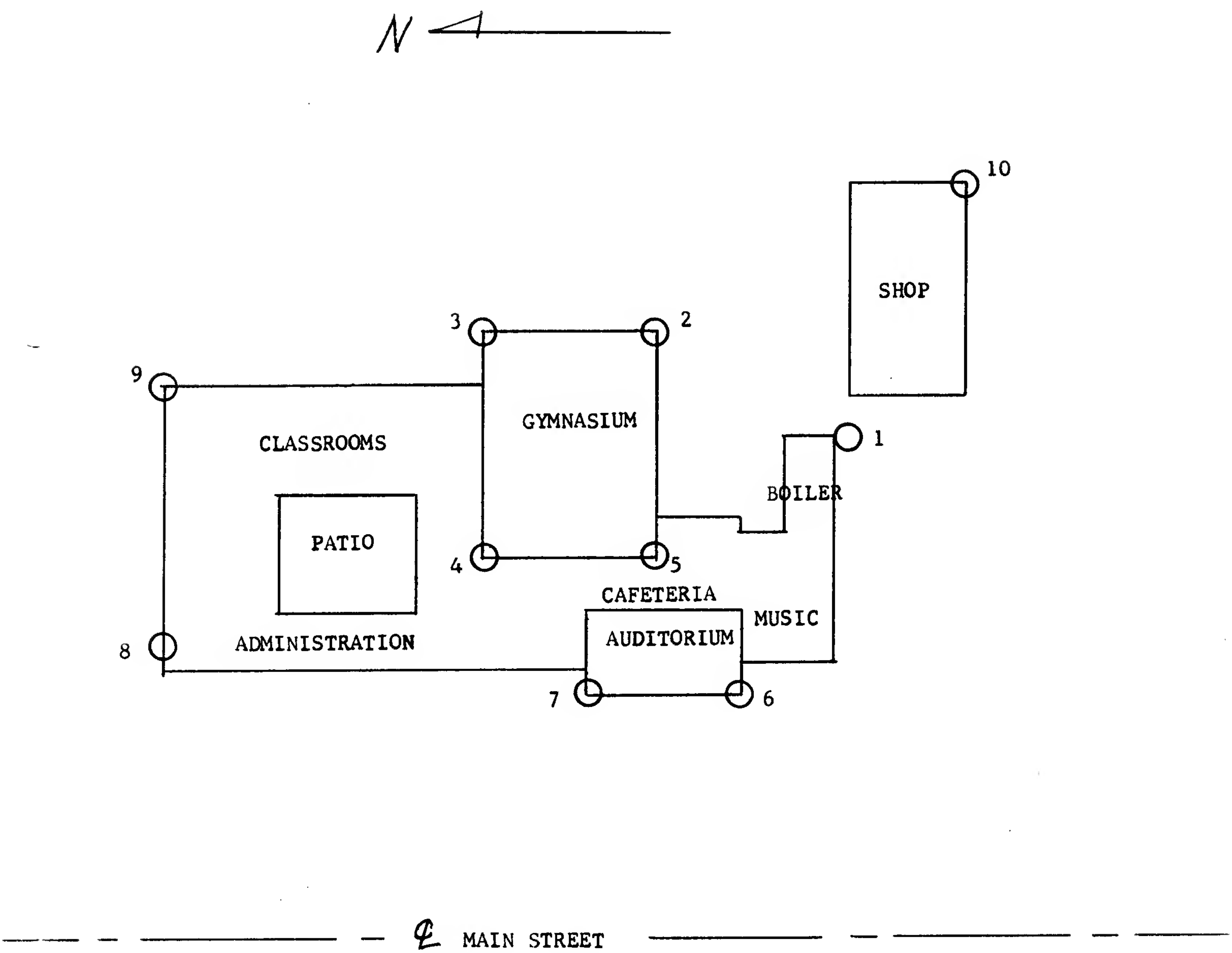


Exhibit 6.

Boring results, Hole No. 1:

0-1'	Topsoil	
1'-6'6"	Stiff brown and blue silty clay	
	at 2-1/2'	N = 9
	at 5'	N = 11
6'6"-13'	Stiff brown and blue inorganic silt with trace of peat	
	at 7-1/2'	N = 11
	at 10'	N = 13
	at 12-1/2'	N = 9
13'-15'6"	Peat and inorganic silt	
	at 15'	N = 12
15'6"-21'	Soft gray inorganic silt	
	at 17-1/2'	N = 4
	at 20'	N = 4
21'-27'	Soft brown and blue sandy, silty clay with trace of small gravel	
	at 25'	N = 3
Below 27'	Hard gray sandy, silty clay with trace of small gravel	
	at 30'	N = 53
	at 35'	N = 45

Quit at 35'

Water level was at 11'6"

Exhibit 7: Bo. ng Results (I)

EXPLORATORY BORING DATA SHEET

Job No. 649

Date March 24, 1959 Location Lewistown, Ill. High School

Operator ETM Ground Surface Elevation 95., 91.2

Depths and Elevations in feet
Strength is Compressive strength
in tons per sq. ft.

Bor.	Samp.	Depth	Elev.	N	Strength Test	Strength Est.	w	LL	PL	Cont.	Description
1	1	2'6		9	2.71		28.2				Mottled gray & brown silty clay with small specks of peat
	2	5'0		11	2.13		31.2				" " " " clayey silt " " " " "
	3	7'6		11	4.25		21.3				Mottled gray & brown silt with trace of clay, occassional small pebbles
	4	10'0		13	–		–				" " " " " " " " " " " "
	5	12'6		9		3.5	23.8				Mottled gray & brown silt with trace clay & occ. speck of black peat
	6	15'0		12	Top	3.5	27.5 82.2				Top, mottled dark gray & brown silt w/trace clay; bott. very dk brown peat, some si
	7	17'6		4		1.0	25.4				Dark gray silt & occ. small black peat pocket with trace clay
	8	20'0		4		1.0	24.8				Dark gray silt with trace clay, occ. sand grains & very fine sand pockets
	9	25'0		3			20.9				Mottled greenish gray & brown clayey fine to med. sand w/occ. pebbles
	10	30'0		53	9.5		8.8				Gray sandy clayey silt with occ. pebbles
	11	35'0		45	9.0		11.3				" " " " " " "
2	1	2'6		7	2.33		26.7				Slightly mottled dark and light brown clayey silt
	2	5'0		16	3.49		26.0				Mottled gray and brown silty clay w/ black peat specks.
	3	7'6		4	–		–				Mottled gray and brown silt with trace of clay & peat specks
	4	10'0		8	–		–				" " " " " " " " " " "
	5	12'6		8	1.55		26.2				Dark brown & grayish brown silt w/some clay, oxidized spots & sand grains
	6	15'0		3		1.0	25.7				Dark gray sandy clayey silt with occasional pebbles
	7	17'6		6	2.33		20.1				Gray sandy silty clay with occ. pebbles & sand pockets
	8	20'0		5	1.55		20.9				" " " " " " " " "
	9	25'0		60	10+		9.8				Gray sandy clayey silt with occasional pebbles

ECL-34

Exhibit 7: Boring Results, cont(II)

EXPLORATORY BORING DATA SHEET

Job No. 649

Date March 24, 1959 | Location Lewistown, Ill. High School

Operator ETM | Ground Surface Elevation 92 ; 97.2

Depths and Elevations in feet
Strength is Compressive strength
in tons per sq. ft.

Bor.	Samp.	Depth	Elev.	N	Strength Test	Strength Est.	w	LL	PL	Cont.	Description
3	1	2'6		5	3.49		26.1				Black silt with some clay & fine sand
	2	5'0		12	2.13		24.1				Slightly mottled gray & brown silty clay with pockets dark brown peat
	3	7'6		8	1.74		23.7				" " " " " " " " " " " "
	4	10'0		5	–		–				Mottled gray and brown clayey silt " " " " "
	5	12'6		6		1.0	25.3				" " " " " " " " " " "
	6	15'0		6		–	23.7				Brown clayey silt with some sand & occ. pebbles
	7	17'6		6	1.55		18.9				Gray sandy clayey silt with occ. small pebbles & sand pockets
	8	20'0		4		1.5	18.1				Mottled gray & brown sandy silt w/some clay & occ. pebbles
	9	25'0		65	10+		9.3				Gray sandy clayey silt with occasional pebbles
4	1	2'6		7	3.49		29.7				Mottled gray & brown silty clay w/specks of black peat
	2	5'0		13	2.70		25.7				" " " " clayey silt " " " " " & occ. pebbles
	3	7'6		9	2.33		25.4				" " " " " " " " " " "
	4	10'0		6	–		–				Mottled gray & brown silt w/trace clay & occ. specks of peat
	5	12'6		3	–		–				" " " " " " " " " " " "
	6	15'0		4	3.5		24.5				Gray silt w/occ. pockets silt; pebbles; & trace peat
	7	17'6		5		1.0	24.9				Gray clayey silt w/slight organic odor
	8	20'0		4		1.0	23.0				Gray clayey silt w/some fine sand
	9	25'0		3		–	–				Gray clayey silty sand with some small pebbles
	10	30'0		40	7.0		8.7				Gray and brown sandy clayey silt w/occ. pebbles

ECL-34

Exhibit 7: Boring Results, cont(III)

EXPLORATORY BORING DATA SHEET

Date March 24, 1959 Location Lewistown, Ill. High School Job No. 649

Operator ETM Ground Surface Elevation 96.5

Depths and Elevations in feet
Strength is Compressive strength
in tons per sq. ft.

Bor.	Samp.	Depth	Elev.	N	Strength Test	Strength Est.	w	LL	PI.	Cont.	Description
5	1	2'6		7	3.88		20.6				Brown and gray silt with some clay
	2	5'0		12	3.88		24.9				Mottled gray & brown silty clay with specks of peat
	3	7'6		8	2.13		25.2				" " " " clayey silt " " " "
	4	10'0		8	—		—				Mottled gray & brown silt with trace clay, occ. pebbles, & specks of peat
	5	12'6		7		3.0	24.2				" " " " " " " " " " " " " "
	6-1	14'0		—		—	—				No sample
	6-2	14'6			3.13 1.04		30.5 105.0				Tannish gray silt with some clay, trace peat Dark brown peat with organic odor - slightly laminated
	6-3	15'0			1.04		67.0				Dark brown peat with organic odor - slightly laminated
	7-1	16'6			—		—				No sample
	7-2	17'0			1.15		22.4				Dark gray & tannish gray silt with some clay & some black organic silt
	7-3	17'6			0.63		25.2				Gray clayey silt with trace fine sand & pebbles
	8-1	19'0			—		—				No sample
	8-2	19'6			1.04		24.8				Gray clayey silt with trace fine sand
	8-3	20'0			1.46		25.5				" " " " " " " & occ. pebbles
	9-1	24'0			1.15		23.3				" " " " " " " " " "
	9-2	24'6			1.04		24.2				" " " " " " " " " "
	9-3	25'0			1.25		23.5				Greenish gray clayey silt w/layers brown clayey sandy silt w/occ. pebbles
	10	30'0		50	10+		11.3				Rust brown & gray brown sandy clayey silt with occ. pebbles

ECL-34

Exhibit 7: Bo ing Results, cont(IV)

EXPLORATORY BORING DATA SHEET

Job No. 649

Date March 24, 1959   Location Lewistown, Ill. High School

Operator ETM   Ground Surface Elevation 94.6

Depths and Elevations in feet
Strength is Compressive strength in tons per sq. ft.

* Bor.	Samp.	Depth	Elev.	N	Strength Test	Strength Est.	w	LL	PL	Cons.	Description
6	1	2'6		6	1.93		29.8				Slightly mottled brown & gray clay w/ trace silt
	2	5'0		10		3.0	23.9				Mottled gray & brown clayey silt with specks of peat
	3	7'6		12	2.5		21.6				" " " " " " " " " "
	4	10'0		5		3.0	23.1				Mottled gray & brown silt w/ trace clay & occ small pebbles
	5-1	12'0			1.04		25.0				Slightly mottled brown & tannish brown silt with trace peat
	5-2	12'6			0.50		136.0				Dark brown to black peat with some tannish gray clayey silt
	6-1	14'6			1.46		66.5				Dark brown peat w/ trace silt & slight organic odor
	6-2	15'0			1.04		82.7				" " " " " " " " " "
	7-1	17'0			1.04		27.9				Dark gray clayey silt with lenses & pockets black organic silt
	7-2	17'6			0.52		27.0				" " " " " " " " fine sandy clayey silt
	8	20'0		3		1.0	25.9				Dark gray silt with trace clay & occ. small peat pockets
	9-1	24'0			—		—				Greenish gray silty clay and silt
	9-2	24'6			0.73		26.0				Greenish gray silty clay w/ pocket fine to med. sand, pebbles
	9-3	25'0			0.84		18.2				Greenish gray clayey silt w/ lenses & pockets clayey sandy silt
	10	30'0		70	7.5		11.6				Gray sandy clayey silt w/ occasional pebbles

ECL-34

EXPLORATORY BORING DATA SHEET

Job No. 649

Date March [illegible], 1959 Location Lewistown, Ill. High School

Operator ETM Ground Surface Elevation 97.2 , 98.4

Depths and Elevations in feet
Strength is Compressive strength
in tons per sq. ft.

Bor.	Samp.	Depth	Elev.	N	Strength Test	Strength Est.	w	LL	PL	Cont.	Description
7	1	2'6		5	3.10		27.1				Mottled chocolate & yellowish brown silty clay w/occ. peat specks
	2	5'0		12	1.74		32.1				Mottled yellowish brown & gray silty clay with occ. peat specks
	3	7'6		9		3.0	22.7				Mottled brown & gray clayey silt with small oxidized sand grains
	4	10'0		6	—		—				" " " " silt w/ trace clay, specks of peat
	5	12'6		2		0.5	26.9				" " " " " " "
	6	15'0		6	2.13		24.4				" " " " " " " " " " "
	7	17'6		6		0.5	24.3				Dark brown to black peat with organic odor
	8	20'0		3		1.0	26.4				Gray clayey silt w/ some fine sand
	9	25'0		4	1.55		22.3				Gray & greenish gray sandy clayey silt w/ occ. pebbles
	10	30'0		46	7.80		10.4				Gray & brown sandy clayey silt with occasional pebbles
8	1	2'6		4	2.70		27.3				Mottled chocolate & yellowish brown silty clay w/occ. specks of peat
	2	5'0		10	1.16		27.1				Mottled brown & gray silt w/ trace clay & occ. specks of peat
	3	7'6		8	1.0		24.4				" " " " " " " " " " " "
	4	10'0		6	—		—				" " " " " " " " " " " "
	5	12'6		7	—		—				" " " " " " " " & 1/4 in. lense brown peat
	6	15'0		15		0.5	81.5				Dark brown to black peat w/ wood fragments & organic odor
	7	17'6		10	1.55		33.3				Dark brown to black organic silt
	8	20'0		9	1.36		24.6				Gray clayey silt with some fine sand
	9	25'0		6	2.33		18.7				Gray & greenish yellowish gray sandy clayey silt w/ occ. pebbles
	10	30'0		40	7.6		10.5				Gray and brown sandy clayey silt with occ. pebbles.

ECL-34

Exhibit 7: Bori..g Results, cont. (VI)

EXPLORATORY BORING DATA SHEET

Job No. 649

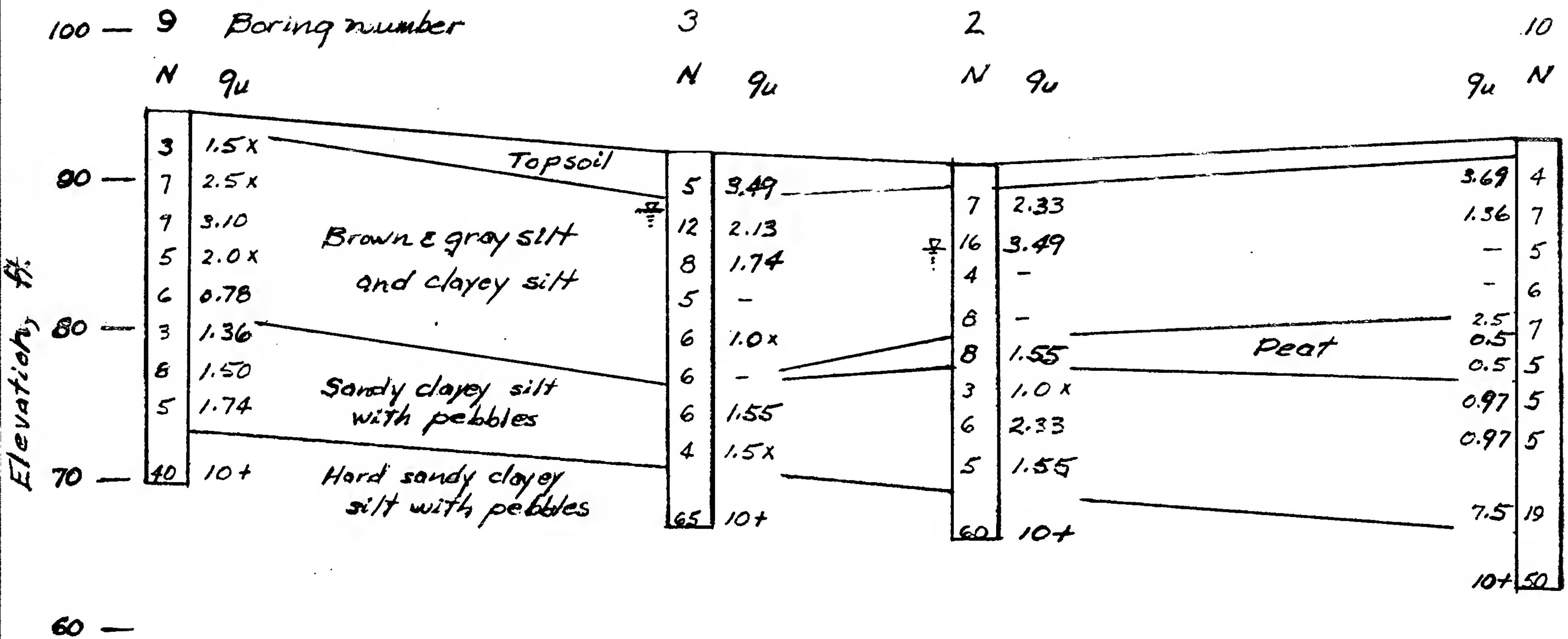
Date March 26, 1959 Location Lewistown, Ill. High School

Operator ETM Ground Surface Elevation 94.9, 93.0

Depths and Elevations in feet
Strength is Compressive strength in tons per sq. ft.

Bor.	Samp.	Depth	Elev.	N	Strength Test	Strength Est.	w	LL	PL	Cont.	Description
9	1	2'6		3		1.5	27.7				Mottled gray & brown silty clay with occ. peat specks
	2	5'0		7		2.5	23.8				Mottled gray & brown silt w/ trace clay & occ. specks of peat
	3	7'6		9	3.10		24.5				Slightly mottled gray & brown silt w/ trace clay & specks of peat
	4	10'0		5		2.0	28.7				Mottled gray & brown silt w/ trace clay, 1/4" layer dark brown peat
	5	12'6		6	0.78		28.1				Dark brown to black organic silt w/ organic odor
	6	15'0		3	1.36		25.6				Gray clayey silt w/ some sand
	7	17'6		8	1.50		23.5				" " " " " " & pebbles
	8	20'0		5	1.74		16.5				Gray & greenish yellowish gray sandy clayey silt with occ. pebbles
	9	25'0		40	10+		9.6				Gray sandy clayey silt w/ occ. pebbles
10	1	2'6		4	3.69		26.9				Yellowish brown silty clay w/ occ. specks dark brown peat
	2	5'0		7	1.36		29.1				Slightly mottled yellowish brown & gray clayey silt w/ specks of peat
	3	7'6		5	—		—				Mottled gray & brown silt with trace of clay, specks of peat
	4	10'0		6	—		—				" " " " " " " " " " " "
	5	12'6		7	2.5 0.5		24.3 65.2				Dark brown " to " black " peat, slight organic odor
	6	15'0		5	0.5		26.9				Dark brown to black peat & organic silt - organic odor
	7	17'6		5	0.97		24.5				Dark gray clayey silt w/ trace of fine sand
	8	20'0		5	0.97		22.2				Gray clayey silt with some fine sand
	9	25'0		19	7.5		11.3				Gray fine sandy silt w/ trace clay & occ. pebbles
	10	30'0		50	10+		10.4				Gray sandy clayey silt w/ occ. pebbles

ECL-34



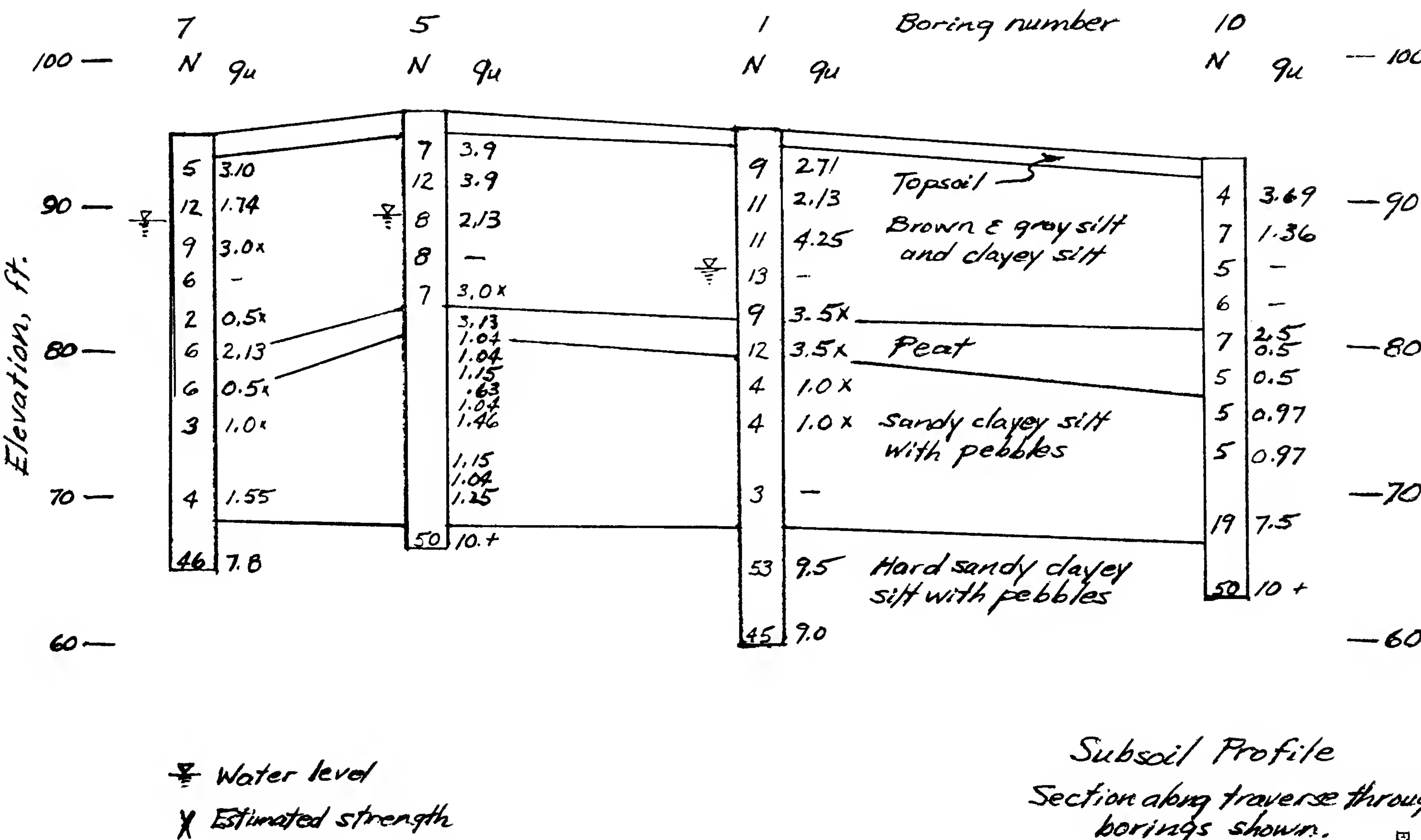
$\overline{\nabla}$ Water level
x Estimated strength

Subsoil Profile
Section along traverse through borings shown.

J649
HOI
4/7/59

ECL-34

Exhibit 7: Boring Results, cont. (VIII)



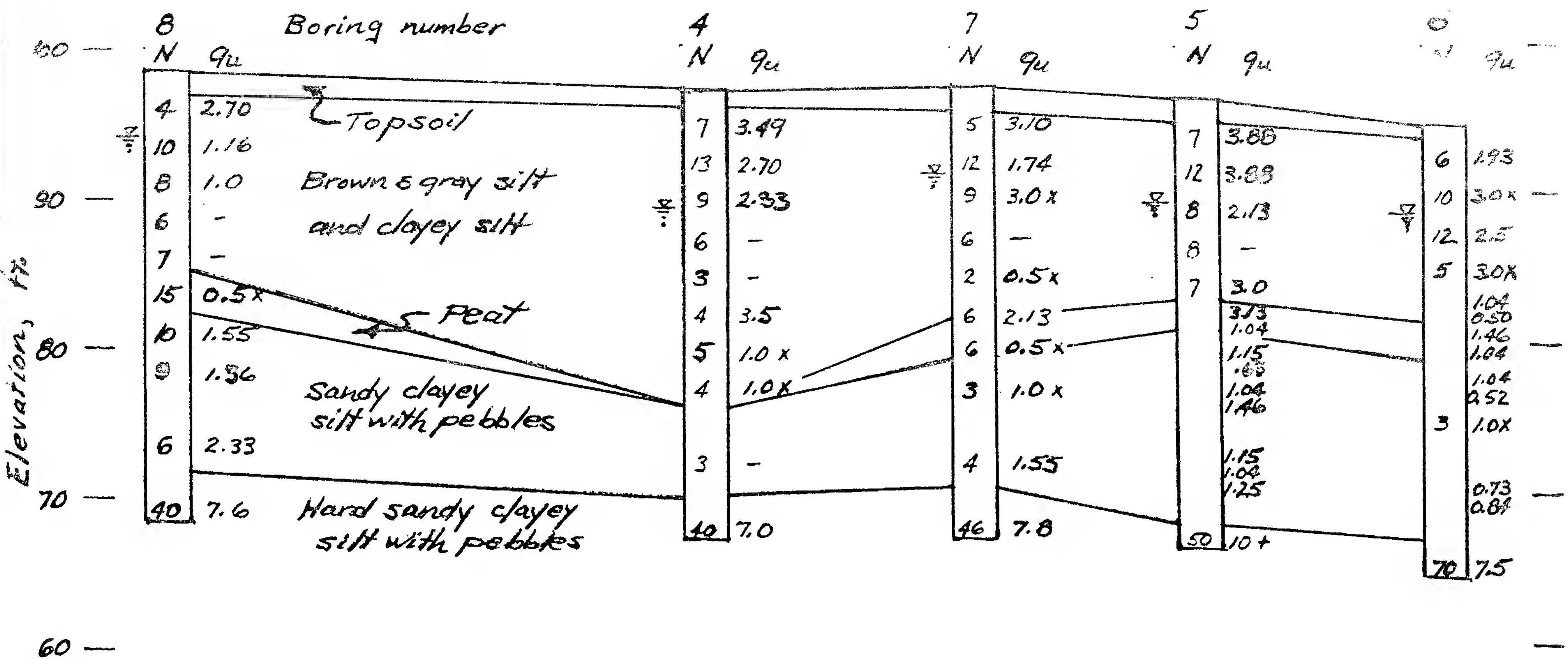
Subsoil Profile

Section along traverse through borings shown.

ECL-34

J649
HOI
4/7/59

Exhibit 7. Boring Results, cont. (IX)



Water level
x Estimated strength

Subsurface Profile

Section along traverse through borings shown.

1649
HQF

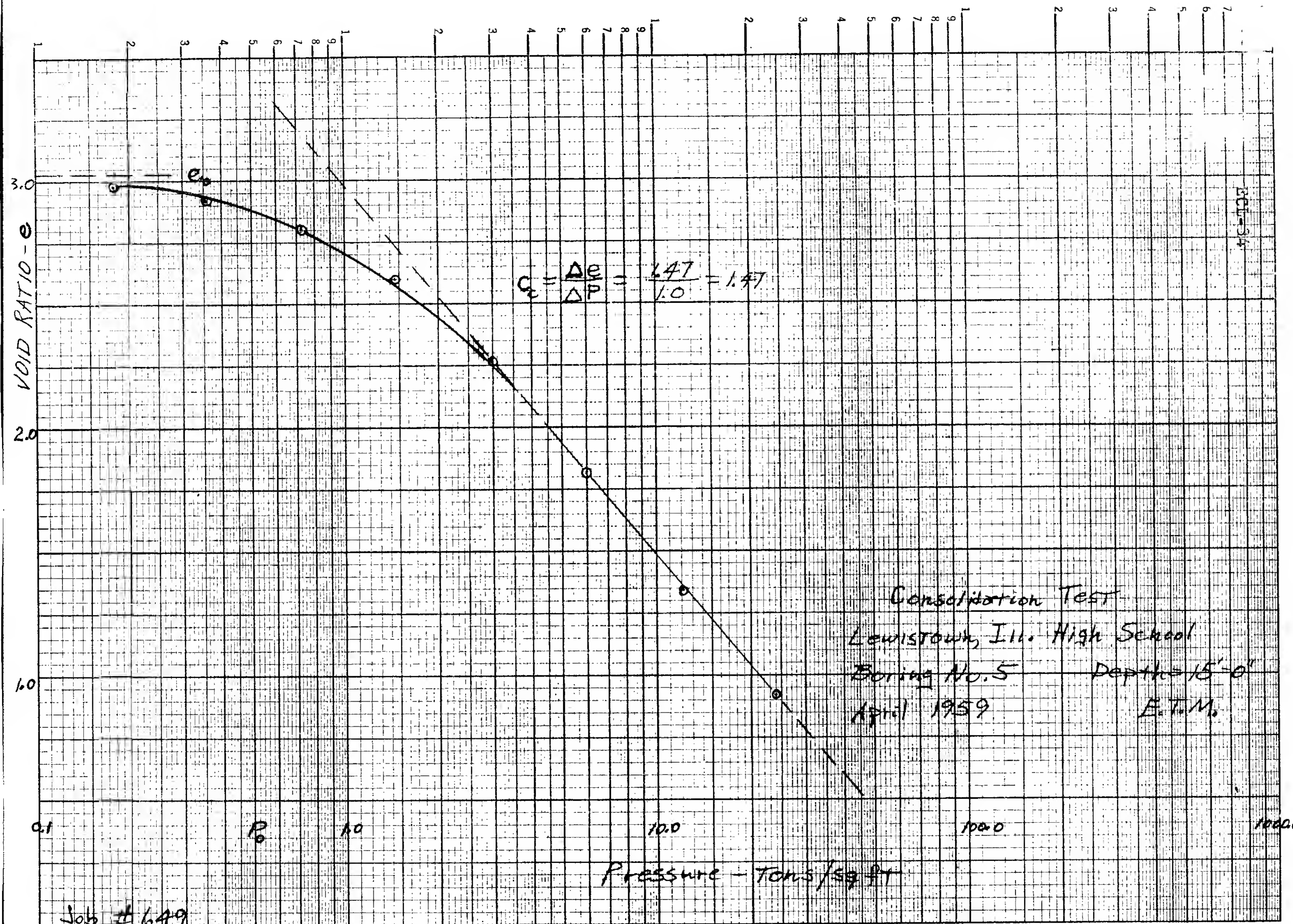


Exhibit 8: e-log p curve from consolidation test.

Exhibit 9.

Wall loads

classrooms	2,900 lb/lin ft.	
gymnasium	$\frac{\text{LL + DL}}{\text{maximum}}$	8,300 lb/lin ft.
	$\frac{\text{live load}}{\text{dead load}}$	= 50%
column load in auditorium	31,900 lb/lin ft. (DL)	
	7,700 lb/lin ft. (LL)	
shop, maximum column load	65,100 lb/lin ft. (Probably due to crane)	
	$\frac{LL}{DL} = 120\%$	

The floor slab of the shop is soil supported except where it spans a utility trench at one end. The anticipated shop floor load is < 40 lb/ft^2

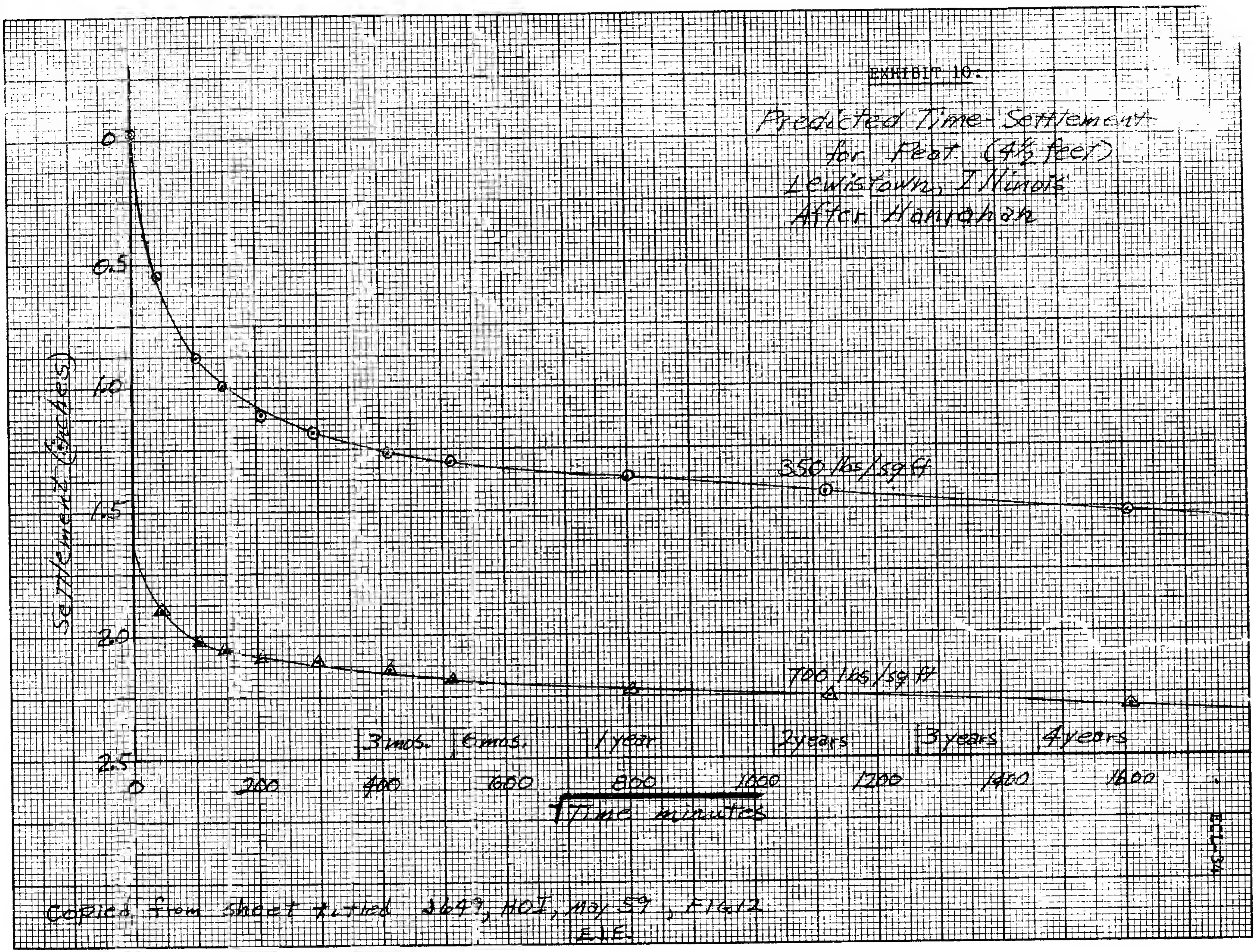


EXHIBIT 10.
Predicted Time-Settlement
for Feet (4½ feet)
Lewistown, Illinois
After Hanrahan
350 lbs/sq ft
700 lbs/sq ft
0
0.5
1.0
1.5
2.0
2.5
Settlement (inches)
3 mos.
6 mos.
1 year
2 years
3 years
4 years
0
200
400
600
800
1000
1200
1400
1600
√Time minutes
Copied from sheet titled 3649, HOI, May 59, FIG 12
EJE.
ECL-34

Exhibit 11: A Portion of the Conclusions and Recommendations from Professor Ireland's Report to the Architect.

Bearing Capacity

The bearing capacity of loess can be determined most accurately by means of field load tests. However, the loessial soil encountered at this site is weathered and has unconfined compressive strengths that are not typical for loess. Therefore, the unconfined compressive strength of the clayey silts at this site are most likely indicative of the strength of this material. When the unconfined compressive strength is a satisfactory measure of the shear strength of a soil, the allowable bearing pressure is approximately equal to the compressive strength. This provides for a factor of safety of about 3 with respect to a bearing capacity failure.

The compressive strengths of the brown and gray silt and clayey silt overlying the peat are generally in excess of 2.0/tons sq. ft. However, weaker areas are indicated as shown by the strength of the samples obtained from boring 8. Except for the uppermost sample, the compressive strengths were only about 1.0 tons/sq.ft. The strength of some of the samples from this boring were not determined because the samples were quite disturbed. This may or may not indicate a weaker material. Based on these conditions, the maximum allowable soil pressure should not exceed 2000 lbs/sq.ft.

Settlement:

Every foundation must not only have a satisfactory margin of safety against a failure, but must support the structure without excessive settlement. The magnitude of settlement that is acceptable depends upon the type of structure, its function, and the cost of reducing the settlement.

The most compressible material encountered at this site is the peat. The exploratory boring data sheets show that its compressive strength is generally in excess of 0.5 tons /sq.ft. and that the maximum water content measured was 136%. In order to check on the compressibility of the peat, a consolidation test was conducted on a sample taken from a depth of 15 ft. in boring 5. This sample was obtained in a 2 in. diameter Shelby tube. The test specimen had a diameter of about 1-3/4 in. and a thickness of 3/8 in. The results of this test are presented in Exhibit 8. This is an e-log p curve where e is the void ratio (volume of voids divided by volume of solids) and p is the applied pressure in tons/sq.ft.

Inasmuch as the rate of settlement for the higher loads continued along a straight line on a semi-logarithmic plot, the curve in Exhibit 8 was arbitrarily plotted at void ratios corresponding to a time of 1000 minutes. This corresponds to about 40 years in the field.

The values of $e_o = 3.04$ and $P_o = 0.5$ tons/sq. ft. correspond respectively to the initial void ratio and overburden pressure in the field. Presumably, if the soil has never been stressed to a higher intensity of load than the present overburden pressure, this point $e_o p_o$, should be located on the e-log p curve representing the material in the field. In such a case, the backward extension of the straight line portion of the laboratory curve usually intersects e_o to the left of $e_o p_o$. However, Exhibit 8 indicates that this intersection is to the right of $e_o p_o$ at $p = 0.9$ tons/sq.ft. This implies that the material has been previously loaded in the field to a stress at least as great as 0.9 tons/sq.ft. and possibly somewhat more and may be regarded as preloaded. The settlement of a normally loaded clay may be computed from the equation:

$$S = \frac{C_c}{1 + e_o} H \log \left(1 + \frac{\Delta_p}{p_o}\right)$$

where C_c is the slope of the straight line portion of the e-log p curve corrected for sample disturbance, H is the thickness of the compressible stratum and Δ_p is the average increase in stress in the compressible stratum due to an applied load near the ground surface. If this procedure is applied to the peat in question, a settlement of 1.78 inches is computed for the most heavily loaded column footing when located over 4-1/2 ft. of peat. This is the maximum thickness of peat encountered by the borings, and it occurs in boring 10. This settlement computation was based on a foundation bearing pressure of 2000 lbs/sq.ft. for combined live and dead loads. If the bearing pressure is taken as 1000 lbs/sq.ft., the computed settlement is 1.39 in. However, if the compressible material is actually preloaded as indicated, the real settlements may not exceed 1/8 to 1/4 of the computed values depending on the magnitude of Δ_p.

Unfortunately, the theory of consolidation for a clay may not apply to a peat. A recent review of the engineering characteristics of peat by MacFarlane[1] indicates that many gaps exist in our knowledge of the engineering properties of peat. The available information apparently is scanty, sometimes contradictory and confusing.

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[1] MacFarlane, Ivan C., "Review of the Engineering Characteristics of Peat," Jour. of the Soil Mech. and Fdns. Div., A.S.C.E., Feb. 1959.

Hanrahan[1] has reported on the results of some laboratory studies of peat carried out in the C. E. Department of University College, Dublin. In this paper it is pointed out that the theory of consolidation has limited application to the problem of forecasting settlements in peat. With respect to consolidation, Hanrahan presents the results of the predicted and measured rate of settlement for a sample 6 inches in diameter by 5.8 inches thick, based on the test results obtained from a sample 3 inches in diameter and 0.75 inches thick. The predicted settlement was in direct proportion to the thickness of the two samples and the corresponding square root of time was taken as the ratio of thickness multiplied by the square root of time as determined from the test. When the large sample was tested, the observed settlement was in excellent agreement with the predicted settlement. It should be noted that the peat used in these studies had a natural water content in excess of 700%.

The above procedure was applied to the peat from the Lewistown site. The results are presented in Exhibit 10 which shows predicted field behavior for two different intensities of added load, 350 lbs/sq.ft. and 700 lbs/sq.ft. These were the first two load increments used in the consolidation test. The stress in the peat at a foundation bearing pressure of 2000 lbs/sq.ft. is about 240 lbs/sq.ft., which is somewhat less than those plotted.

Exhibit 10 indicates that the settlement of the 4-1/2 ft. of peat for an applied stress of 350 lbs/sq.ft. is on the order of 1.5 inches and that most of this may be expected within the first year.

In addition to the settlement that may be contributed by the peat, some additional settlement should be anticipated from the silts. This cannot be accurately forecast, but is not likely to be of major importance.

Recommendations

The preceding discussion indicates that spread footing foundations may be used for the proposed structure but that settlement should be anticipated. This will most likely produce wall cracks which may tend to open further with time. The simplest way to avoid the settlement is to place the proposed structure on pile foundations. The piles would be 25 to 30 ft. in length and would add materially to the cost of the project. However, there are strong indications that the peat is preloaded and will not settle as much as anticipated. Therefore, the following recommendations are presented.

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[1] Hanrahan, E. T., "An Investigation of Some Physical Properties of Peat," Geotechnique, Sept., 1954.

It is recommended that the proposed school be established on footing foundations located at the highest practicable elevation but below the existing topsoil. These should be proportional for uniform dead load soil pressures such that the combined live and dead loads do not exceed 2000 lbs/sq.ft. The dead load should include all loads which will act for the majority of the time and the live load should not be overestimated.

In order to minimize the settlements that may occur, it is necessary to avoid the use of fill wherever possible. Two feet of compacted fill will transmit a stress of about 250 lbs/sq.ft. to the peat. This should be regarded as the maximum permissible height of fill and even this should be avoided if possible. Where compacted fill must be used, the material should be placed at a moisture content corresponding to the plastic limit. This is the moisture content at which a thread of the material 1/8" in diameter can be rolled out but when immediately remolded and rolled out again, crumbles and is no longer plastic. This material should be placed in layers about 4 in. thick (certainly not more than 6 in.) and compacted by suitable compaction equipment. Soil that is too dry or too wet cannot be properly compacted and will cause subsequent maintenance problems.

Soil supported floors should be separated from foundation wall or columns by a suitable construction joint so that the wall or column is free to move relative to the floor.

Vertical construction joints are required at each change in configuration of the structure. These should be arranged to help localize any cracks that may tend to open so that the cracks do not wander aimlessly around corners from one wall to another. Since it appears that the majority of the settlement may take place during the first year, it is suggested that the interior decorating might be delayed one year. At this time, any cracks which might appear can be pointed up and hidden by the first job of interior decorating which should be expected to thereby have a longer, more useful life.

Field Observations

It is rather important to determine the behavior of this structure. It will be useful to learn its time settlement history and to determine if possible whether or not the peat behaves as if it were preloaded. Therefore, a suitable system of reference marks should be located on at least the exterior walls. These should be established at the earliest possible date and level observations recorded for them at monthly intervals from this date throughout the construction period and thereafter as may be required. Suitable notes should be kept to indicate the stage of construction when each level survey is made to assist in estimating the actual load on the footings at that time. Such records might indicate whether or not any advantage can be obtained by delaying the interior decorating.

H. O. Ireland